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The MagPi

The official Raspberry Pi magazine | Issue 62 | October 2017 | raspberrypi.org/magpi

HYDROPONIC PI GARDENING

How does your garden grow? Perfectly with Raspberry Pi

THE MESMERIC MIRROR PROJECT

Motion-sensing mirror lights up when it detects humans

LEGO and Raspberry Pi

Build something brilliant with blocks

CONTROL DEVICES WITH NODE-RED

Discover visual programming for Internet of Things projects

AMAZING INSTANT GIF POLAROID CAM

The Raspberry Pi camera that prints out animated images

WEEKEND PROJECTS

Impressive two-day builds

Also inside:

- SIMULATE CIRCUITS ON YOUR RASPBERRY PI
- BUILD A PROFESSIONAL PI PODCAST STATION
- MEARM PI ROBOTIC ARM TESTED & RATED
- SPOOKY HALLOWEEN HEAD 'N RON COLLIDER

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WELCOME TO THE OFFICIAL MAGAZINE

LEGO is one of the most wonderful things in the world. From the 1980s 'What it is is beautiful' advert, to *The LEGO Movie*, it has provided inspiration that spans generations. LEGO was also the universally loved toy when *The MagPi* team was young. It has been a constant presence through our lives, regardless of our ages or backgrounds.

I like to think there's a lot that Raspberry Pi and LEGO have in common, and the team's been hankering after making a LEGO feature for a while. It's not just childhood nostalgia – we feel it's just as useful for adults. The free-range creativity that makes LEGO so much fun when you're a kid is what makes it useful as a digital maker. You can make just about anything, given enough LEGO bricks.

Our LEGO and Raspberry Pi feature (page 16) is spectacular. You will learn how to build LEGO robots that solve Rubik's Cubes, Segway-style self-balancing robots, and retro NES games consoles; and marvel at a huge bunch of incredible community builds based on LEGO.

So don't be afraid to add some LEGO to your projects. It's a versatile building material that you can use, and reuse, across a range of builds. Everything is awesome!

Lucy Hattersley
Editor - The MagPi

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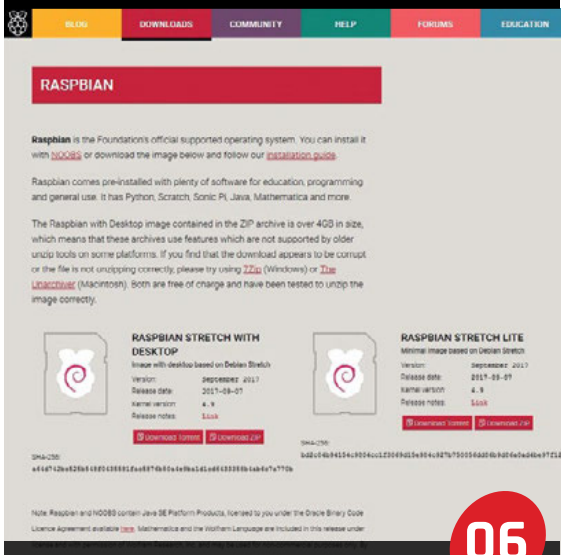

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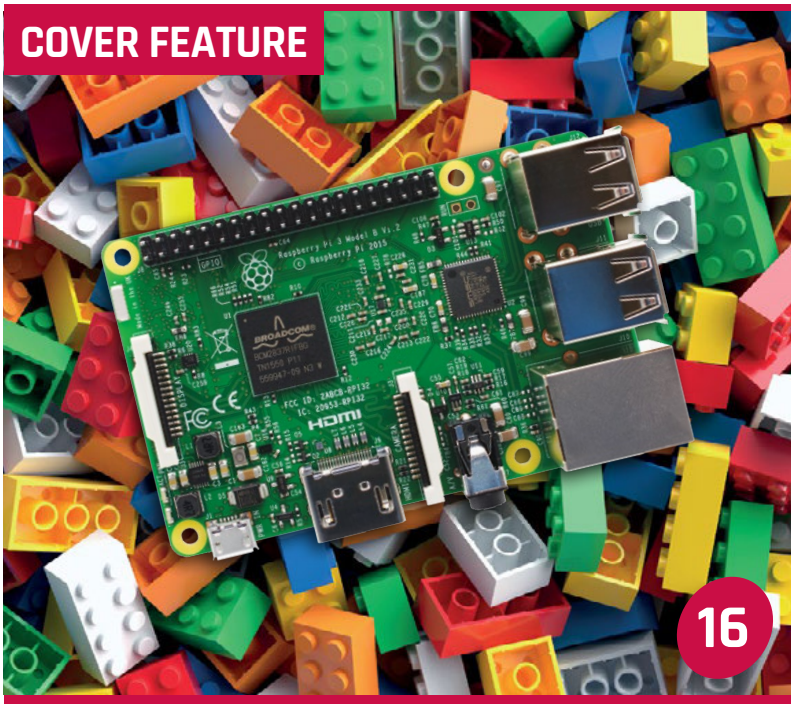

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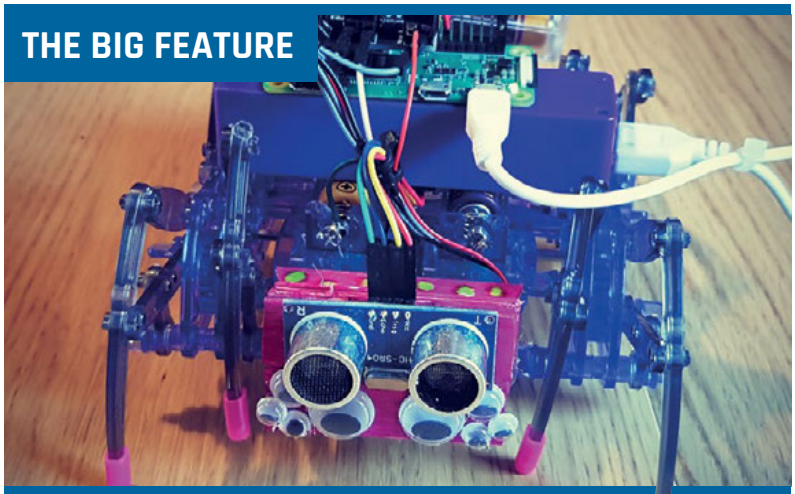

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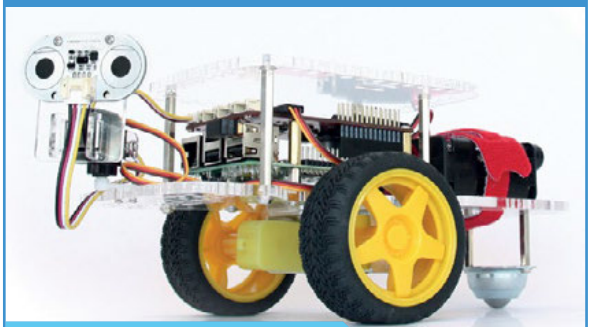

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RASPBIAN STRETCHES OUT

Meet Stretch, and discover all the new features in Raspbian

The latest version of Raspbian has been released. Code-named Stretch (named after the purple octopus of *Toy Story 3*), there are a few under-the-hood changes that should simplify some aspects of working with a Raspberry Pi.

Unlike last year's Jessie update, there's not much visual change between the previous version (Jessie, the plucky cowgirl) and Stretch. However, you don't have to dig too deep to find some useful updates.

Multiple users are handled better under Stretch. Raspberry Pi Foundation UX Engineer Simon Long explains that this is "something we have done to make life easier for schools and the like [e.g. Code Clubs and CoderDojos], which want to use multiple users on a single Pi."

"The Raspberry Pi Configuration application no longer assumes that it will always be run by the 'pi' user," explains Simon. "If this is used to enable automatic login, it now sets it up for the current user. If passwordless sudo has been disabled for the current user, applications which require sudo will now prompt for a password at start rather than just failing to launch."

Of Bluetooth and databases

Bluetooth support in Stretch is now handled by bluez-alsa rather than PulseAudio. As Simon clarifies, "the previous approach using PulseAudio was a bit clumsy, and necessitated my taking control of PulseAudio and starting and stopping it when Bluetooth devices were selected or removed."

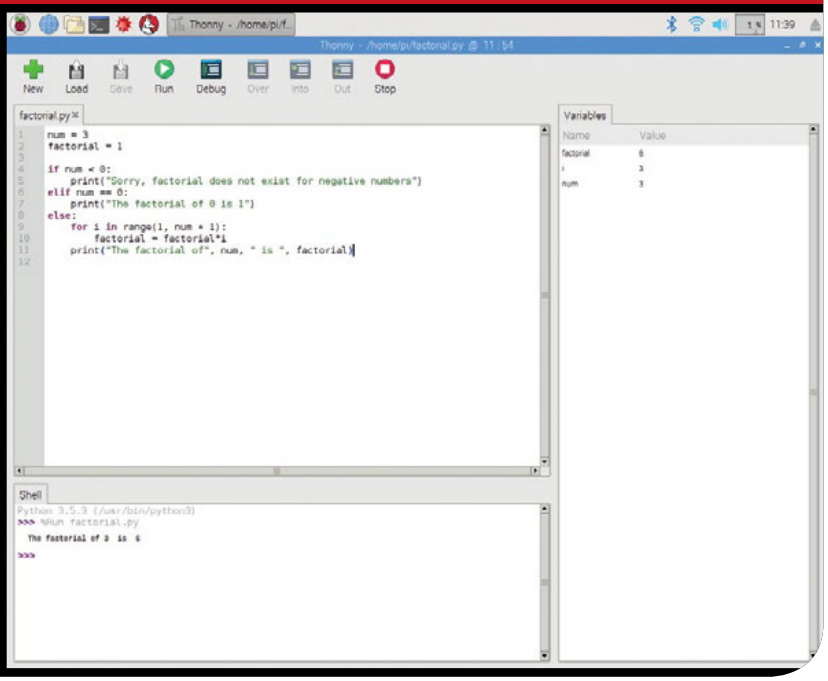
Stretch frees PulseAudio for use in other projects (you'll need to install it first), while "the change does also make things tidier inside the code itself," according to Simon, who confirms

THONNY (SIMPLE MODE)

Thonny Python IDE has been updated with a new Simple Mode, available as a second app (click Menu > Programming > Thonny (Simple Mode).

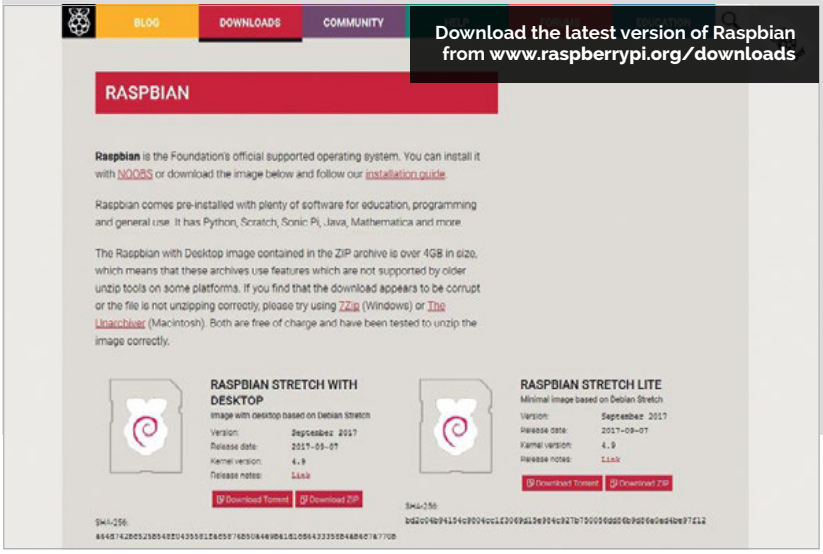
Simple Mode strips Thonny down to the bare essentials required for starting with Python. It removes the configurable layout options in favour of a fixed selection of useful windows. The menus have been removed and larger captioned icons included. These are more immediately visible, and enable users to Save, Load, Run/Stop and Debug scripts.

We expect Thonny (Simple Mode) to be very useful for Python training.



"there should be no significant differences in [Bluetooth] performance or quality."

As Raspbian follows Debian's update schedule, MySQL has been dropped in favour of MariaDB (**mariadb.com**). Simon explains that "we follow Debian except in cases where a) we have added a package ourselves or b) we have fixed a bug or changed functionality in a Debian package. As this is neither of those cases, we simply follow Debian." Simon also notes that, as Debian drops PHP5 for PHP7, so does Raspbian.


BLOG
DOWNLOADS
COMMUNITY
RASPBIAN
Raspbian is the Foundation's official supported operating system. You can install it with NOOBS or download the image below and follow our installation guide.
Raspbian comes pre-installed with plenty of software for education, programming and general use. It has Python, Scratch, Sonic Pi, Java, Mathematica and more.
The Raspbian with Desktop image contained in the ZIP archive is over 4GB in size, which means that these archives use features which are not supported by older unzip tools on some platforms. If you find that the download appears to be corrupt or the file is not unzipping correctly, please try using 7Zip (Windows) or The Unarchiver (Macintosh). Both are free of charge and have been tested to unzip the image correctly.
RASPBIAN STRETCH WITH DESKTOP
Image with desktop based on Debian Stretch
Version: September 2017
Release date: 2017-09-07
Kernel version: 4.9
Release notes: Link
Download Torrent
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RASPBIAN STRETCH LITE
Minimal image based on Debian Stretch
Version: September 2017
Release date: 2017-09-07
Kernel version: 4.9
Release notes: Link
Download Torrent
Download ZIP
Download the latest version of Raspbian from www.raspberrypi.org/downloads

> "Raspbian Stretch will 'make life easier for schools and the like, which want to use multiple users on a single Pi'"

If your build relies on MySQL and you don't fancy porting it to MariaDB, you can still install MySQL on Stretch.

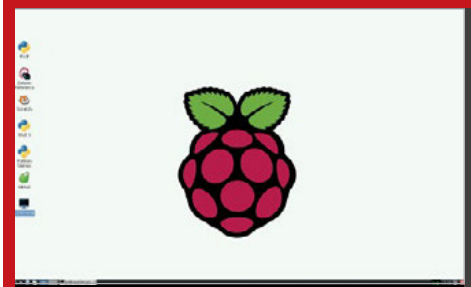
Other updates

Raspbian Stretch ships with Sonic Pi 3.0.1, which Simon says "includes a lot of new functionality in terms of input/output." Chromium has been updated to version 60, which may run "slightly faster than before" thanks to some code optimisations.

Scratch 2 receives the Sense HAT extension, allowing you to tinker with the virtual Sense HAT as well as the real thing. Look under More Blocks and select Add an Extension.

It's best to do a clean install of Stretch (back up any data on your Jessie-based system first) by downloading the image from **magpi.cc/2eHd8M3**.

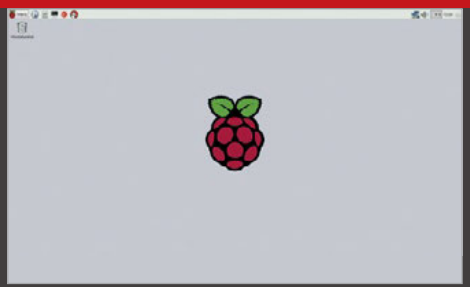
RASPBIAN THROUGH THE AGES



WHEEZY

July 2012

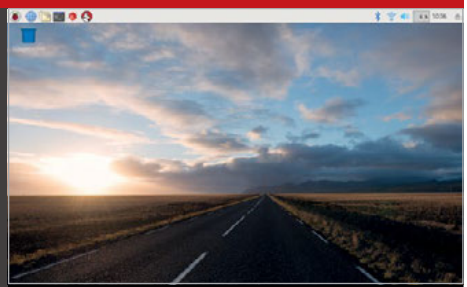
Before Raspbian, there was Debian, but Raspbian was the ARM port of Debian to run on the Raspberry Pi . Raspbian was created by Mike Thompson and Peter Green as an independent project. The numerous tweaks and performance improvements made Raspbian a highly customised environment, eventually becoming the offically supported OS.



RASPBIAN JESSIE

September 2015

The first major overhaul of Raspbian saw, in Simon Long's words, "modifications to the underlying system to improve system processes" as well as desktop interface updates, such as booting to the desktop rather than the command line. LibreOffice, Claws Mail, and a GUI version of raspi-config were added.



ALL NEW DESKTOP

September 2016

Just a year later, Jessie saw a massive update to its visual desktop interface. With gorgeous background images and a modern treatment for icons, menus, window frames, and scrollbars, Raspbian with the Pi Desktop is every bit as slick as operating systems running on hardware a hundred times more expensive.

INTELLIGENT MUSEUMS

A bespoke experience for every visitor

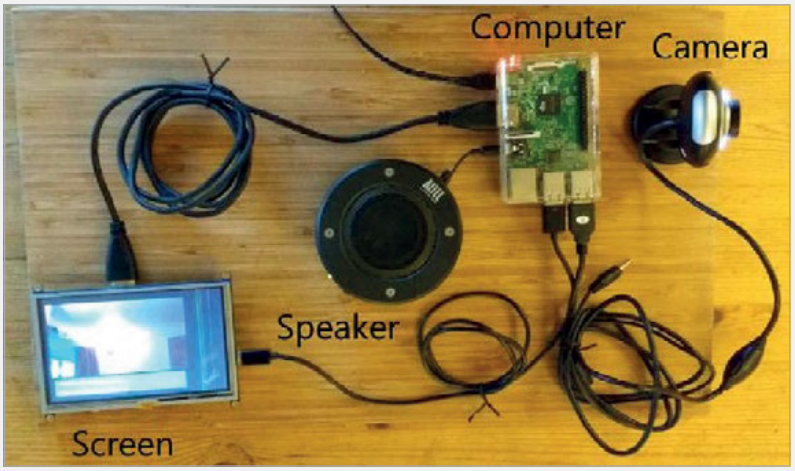
Shrewsbury Museum & Art Gallery (**magpi.cc/2vIdFEB**) hosted a week-long hack, allowing Microsoft and consultancy firm Black Radley (**blackradley.com**) to create an intelligent exhibit.

While many museums use multimedia elements for certain exhibits, these videos or talks are the same, whether a child or a 70-year-old activates them. The hack team wanted to do better.

The aim was to make a system that would serve content suited to the demographic and engagement of the visitor.

Open source

Integral to the brief was that the project should use open-source software and hardware costing less than £100, so an old webcam and speaker were hooked up to a Raspberry Pi 3. The Pi used a UWP (Universal Windows Platform) on Windows IoT Core to access facial recognition algorithms via Microsoft's Cognitive Services Face API.

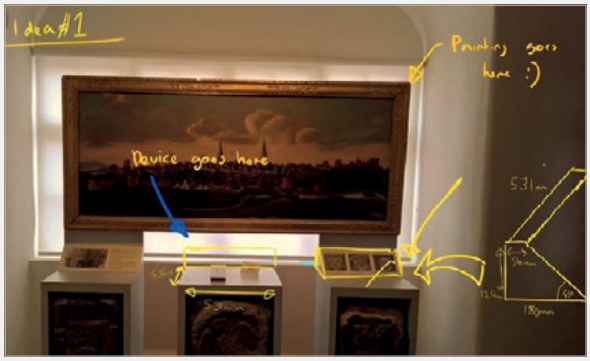


Above The device uses a webcam that was "languishing in the back of the cupboard"

Black Radley's Joe Collins explains that "using a webcam gives us a bit of flexibility because they often come with quite a long cable."

> "Keeping the project open-source allows the museums to adapt the device to their own needs"

Hack collaborator and Microsoft Technology Evangelist Martin Kearn adds that the use of Windows IoT Core "enables us to support almost any webcam that is supported on Windows, on any device."



Left In true hacker style, this was the plan for the device

Joe explains that the Pi 3 was used because "it is handy to have the USB sockets for the webcam and to power the speakers." You could use the project code (**magpi.cc/2gCYfqQ**) on a Pi Zero W, or as Martin points out, on "laptops, desktops, tablets, phones, Xbox, 80-inch Surface Hubs", or anything that can run Windows 10.

It was important to the hack team that the project was open-source because, as Joe tells us, "there are a lot of museums out there [...]. Keeping the project open-source allows the museums to adapt the device to their own needs."

Martin adds that "Microsoft is a big advocate of open-source technologies [...]. When we engage in 'code with' activities with customers and partners, we always like the project itself to be open-source."

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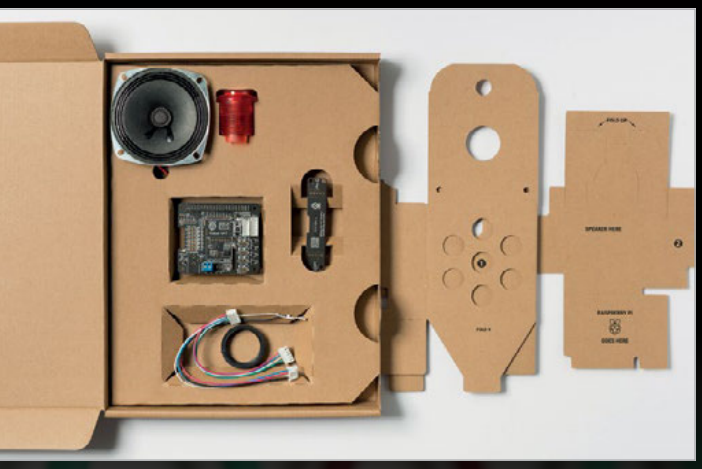
AIY PROJECTS VOICE KITS PRE-ORDER



Above The new AIY kit comes with a 76-page *The MagPi* Essentials book to guide you from cardboard to complete build

Below The new kit is easier to build, with "a vastly improved API" to make projects easier to create

Pre-order your Google AIY Projects Voice Kit

Following overwhelming popularity of the free Google AIY Voice Kits we offered with issue 57, the kits are being made and sold as standalone products.

You can pre-order kits in the UK from The Pi Hut (**magpi.cc/2hkKbCI**) and Pimoroni (**pimoroni.com/aiy**) for £25, or in the US from Micro Center (**magpi.cc/2heOVxa**).

> "As long as there is demand, we plan to keep making them"

The new kits are easier to assemble than the initial freebies, with "a vastly improved API that makes it a lot easier to program" according to our own Editor, Lucy Hattersley.

The kit will also come with a 76-page *The MagPi* Essentials book to get you started. As Lucy puts it: "The new *AIY Projects* Essentials book is a brilliant introduction to voice recognition technology using Google Assistant SDK and Google Speech APIs."

The kits are made and distributed by US retailer Micro Center (**www.microcenter.com**), as merchandise manager Samantha Snyder explains: "Originally, we approached Google with a large order of kits to give away to our customers who purchase a Raspberry Pi 3, after the massive demand for *The MagPi* kit."

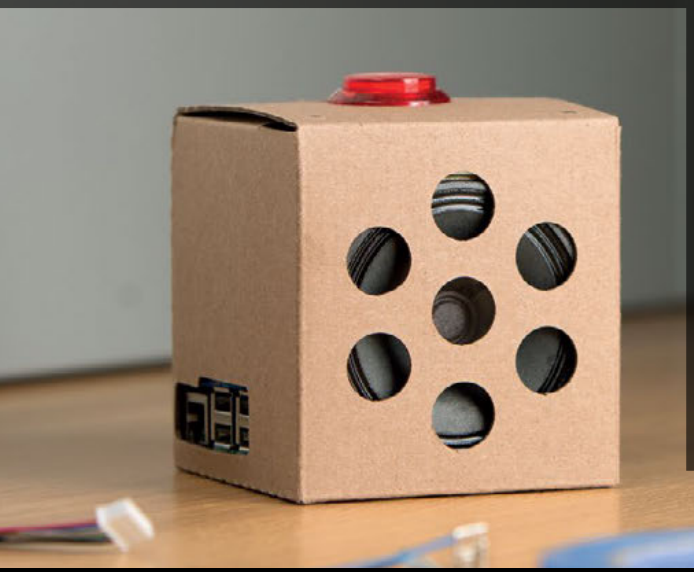
"We immediately volunteered to handle manufacturing and logistics," she adds.

Sold out?

You shouldn't have to worry about the kits selling out: "as long as there is demand, we plan to keep making them," confirms Samantha. Micro Center has "been tracking their demand closely to ensure they will stay in stock," she tells us.

Pimoroni director Jon Williamson agrees: "Initial unit count shouldn't be an issue … we expect to be able to get hold of as many as needed, within reason."

Samantha also confirms that "We plan to work with Google and the Raspberry Pi Foundation to provide feedback on the kits." The future of AIY Projects is bright.



PI 3 MAKES 'ULTIMATE EDUCATION LIST'

As essential as a multimeter or microscope

The Raspberry Pi 3 has made Farnell element14's ultimate education list, making a Pi 3 as indispensable to the engineer as a multimeter, oscilloscope or 3D printer.

Farnell element14 is a major Europe-wide distributor of electronics, technology and electronic system designs, and maintenance and repair services. Farnell element14's Business President for Sales and Marketing Europe, Peter Birks, says of the list, "Supporting the education of engineers is vital to ensure that the next generation has the talent to drive our industry forward."

Global head of PR and External Communication, Holly Smart, explains why the Pi 3 was chosen: "We believe the Pi 3 has one of the best SBC [single-board computer] propositions on the market: compatibility, community support, ecosystem, software, and tutorials; combined with the performance-to-price ratio, that's fantastic."

> "We believe the Pi 3 has one of the best SBC propositions on the market"

Farnell directly helps in the training of engineers too, as Holly tells us: "Farnell staff regularly support local schools and universities with coding clubs, science fairs, and general electronics."

Below The Pi 3 is as essential and useful as this £5,500 Keysight N6705C Power Analyser

NOW TRENDING

The stories we shared that flew around the world

RASPBERRY PI DESKTOP X86

magpi.cc/2wkkThL

Now you can use Raspbian on your laptop or desktop PC. Just download the image from **rpf.io/x86** (or use the DVD mounted on the front of issue 60) and install it to a USB drive using Etcher (**etcher.io**). Boot from the USB drive to replace Windows or macOS with a fast, modern, and secure alternative.

RUN WINDOWS AND OTHER X86 SOFTWARE ON YOUR PI

magpi.cc/2wgLo7N

The Eltechs ExaGear Desktop allows you to run any software on a Raspberry Pi, whether that's Windows games, standard x86 Linux software, Microsoft Office or even a browser that will display Netflix video. In our review, we concluded, 'ExaGear is worth its lifetime price if you need a specific piece of x86 software.'

10 MILLION WELSH PIS MADE

magpi.cc/2vTqSG4

The Sony UK TEC manufacturing plant in Pencoed, South Wales, was originally contracted to make 10,000 Raspberry Pis. Five years later, the factory has just produced its ten millionth. In fact, one million Raspberry Pi boards were made in the first year alone – quite the achievement considering that tentative first order.

REMOTE-CONTROLLED PI POWER SWITCH

Hackable board adds sofa-based power control

Fresh from Kickstarter success, the Nanomesher Hackable Switch has hit the shelves. The device sits between the power supply and the Pi's power input, essentially adding a remote-controlled power switch to the Pi.

The 'hackable' trick with the device is its socket-mounted ATtiny85 Arduino Development MCU. Lift this chip from its seat, plug it into a breadboard, and you can reprogram it to behave as you like.

Nanomesher provides a guide to reprogramming the teeny ATtiny chip: **magpi.cc/2wDfrnz**.

Tech tester and ModMyPi CEO Jacob Marsh wanted to stock the device because it's a "very nice power switch, with some added hackability features. What's not to like? We especially liked the fact that it comes pre-assembled with an IR remote, all ready to rock."

Left and below An IR, remote-controlled power switch with hackability

Alas, the IR input of the hackable power switch means it's incompatible with the (RF) OSMC Remote Control. The hackable power switch is available now from ModMyPi for £22 (**magpi.cc/2eHjqeA**).

ANDROID THINGS ENHANCES PI SUPPORT

New Pi-specific features for better IoT devices

Google has added a few Pi-specific updates to the latest build of its Internet of Things OS, Android Things.

Above The latest IoT OS from Google includes some "highly requested features" for Pi support

Developer Advocate for IoT, Wayne Piekarski, points to two major updates in Android Things DP5: OpenGL ES 2.0 support and WebView. Both of these features were "highly requested features from developers," according to Wayne.

Flexible connections

OpenGL ES 2.0 is a graphical API for 2D and 3D graphics, so we can expect more visually impressive Pi-based Android Things interfaces. WebView allows the opposite: it's an API to show web-like content (basic HTML, for example) without the extras. JavaScript, HTML5 video and so on can be 'injected' back into the page, as detailed in the WebView manual (**magpi.cc/2wCCqki**). As such, WebView might prove to be a handy way to connect with an IoT device as quickly and responsively as possible.

Finally, Android Things DP5 adds dynamic pin muxing for the Pi 3, "with pins being configured at runtime depending on what features are being used," Wayne clarifies.

ASTRO PI IS GOING BACK TO SPACE

ISS upgrade will add WiFi dongles to Astro Pi units

The Atlas V rocket. Image credit: NASA/United Launch Alliance

The Astro Pi team is putting together a new payload to upgrade the two Raspberry Pi units on board the International Space Station.

The upgrade, due to launch in January 2018, will provide two USB WiFi dongles, five optical filters, and four 32GB microSD cards for the two Astro Pi units, nicknamed 'Ed' and 'Izzy'.

Alongside the new launch comes a new set of missions for students. Astro Pi is searching for the next generation of space scientists, and wants to inspire as many students as possible to take part in space science with code.

This year, there are two different missions for students to enter (see 'Astro Pi Missions' box). After registering for the missions, students will work like real scientists to design their own programs and experiments.

"We're preparing young people for the jobs of the future," says Dave Honess, Astro Pi Programme Manager. "We want to show the possibilities of computer programming as a digital skill, and encourage young people of school age towards further study of STEM subjects and associated careers – Astro Pi being especially relevant to the aerospace industry, which will see huge growth over the next 20 years. Astro Pi gives each student the opportunity to be an active participant in space science, rather than just an observer. Having a creation of theirs reach space and do something there is profoundly cool."

Student teams can register for the missions at **astro-pi.org**.

ASTRO PI MISSIONS

This year, there are two missions available for Astro Pi. Teams must enter by the deadline, but the competition then runs into 2018 alongside the mission launch.

MISSION SPACE LAB

magpi.cc/2xikb54

Registration closes: 29 October 2017

- A scientific mission for young people no older than 19
- Design an experiment, receive free computer hardware to work with, and write the Python code to carry it out
- Your code could be uploaded to the International Space Station and run for three hours (two orbits)
- Get your results back from space and analyse them like a real space scientist
- The ten best final reports will win special mentions and exclusive space-related prizes

MISSION ZERO

magpi.cc/2fkznHZ

Participation closes: 29 November 2017

- A non-competitive mission for young people no older than 14
- Write a simple Python program using free online tools
- Provided you adhere to a few rules, your code is guaranteed to run in space for 30 seconds
- Receive a certificate showing the exact time when your code was running on the ISS

DEXTER INDUSTRIES

GoPiGo

20+ new projects for your Pi robot car.

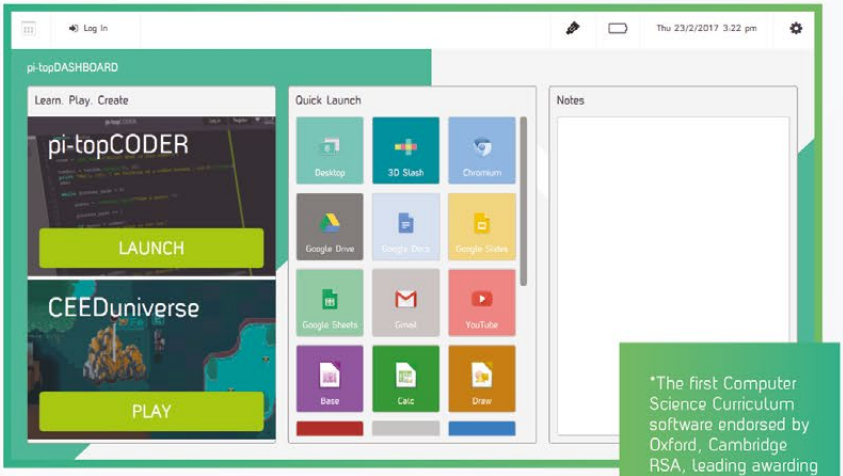
BrickPi3

LEGO MINDSTORMS + RASPBERRY PI

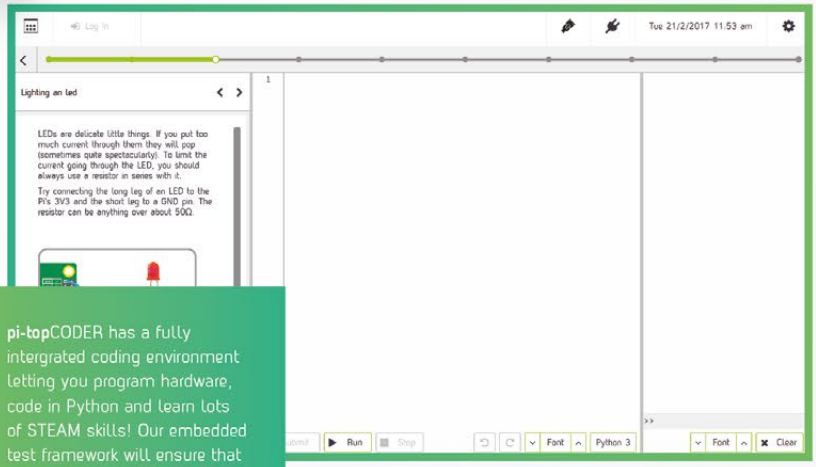
www.dexterindustries.com

pi-topOS

The OCR* endorsed **pi-top**OS (Operating system) platform comes pre-installed on the 8GB SD card shipped with every unit. **pi-top**OS software suite lets you - browse the web, - check emails, - create and edit Microsoft Office compatible files. It includes **pi-top**CODER and comes with the revolutionary educational game CEED**universe**.



*The first Computer Science Curriculum software endorsed by Oxford, Cambridge RSA, leading awarding body - **OCR**.


Lighting an led
LEDs are delicate little things. If you put too much current through them they will pop (sometimes quite spectacularly). To limit the current going through the LED, you should always use a resistor in series with it.
Try connecting the long leg of an LED to the Pi's 3V3 and the short leg to a GND pin. The resistor can be anything over about 50Ω.
Run
Stop
Font
Python 3
Clear

pi-topCODER has a fully intergrated coding environment letting you program hardware, code in Python and learn lots of STEAM skills! Our embedded test framework will ensure that you understand all concepts.

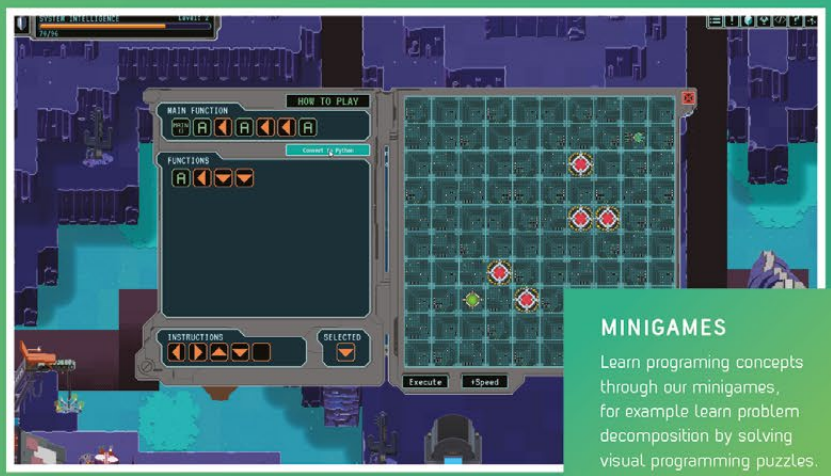
pi-topCODER

pi-topCODER is the interface that allows you to access worksheets and pre-built Raspberry Pi projects. It's the easiest way to tinker or deliver lessons by providing step-by-step guides for computer science and STEAM worksheets.

CEED**universe**

CEEDuniverse is our educational game. It's a world of fantasy developed in line with the computing curriculum – taking science fiction and transforming it science. It is a FREE massive role-play game carefully crafted by **pi-top**. The game teaches students to solve computational puzzles, how to code in Python and build physical circuits which interact with the game.

Exploring the planet, the students first encounter 'drag & drop' coding puzzles and move on to writing text based code.



MINIGAMES

Learn programing concepts through our minigames, for example learn problem decomposition by solving visual programming puzzles.

BT More power to you
CPC
Findel Education Resources The choice for schools for classrooms for specialists
MISCO
RS
ypo

pi-top

WWW.PI-TOP.COM

POWERED BY RASPBERRY PI

LEARN
PLAY
CREATE

pi-topCEED

The modular all-in-one
Raspberry Pi powered desktop

- Adjustable Viewing Angles
- 14" HD Screen
- Modular Components

pi-top

The modular build-it-yourself
Raspberry Pi powered laptop

- 10 Hour Battery Life
- 13.3" HD Screen
- Modular Components

NEW

pi-top | Worldwide shipping available in green or grey at www.pi-top.com or our distributors
Stay up to date with our latest news by following our social media

LEGO and Raspberry Pi

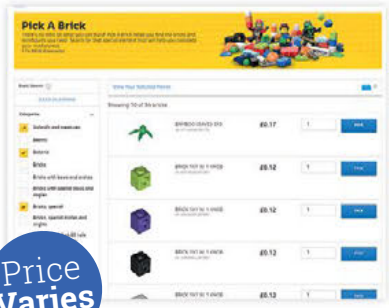
BUILDERS AND MAKERS UNITE TO CREATE AWESOME **PI-POWERED LEGO PROJECTS**

LEGO has always inspired people. While it is undeniably satisfying to build a set like the UCS Millennium Falcon, there is nothing as inspiring and creative as a child with a box of LEGO pieces. LEGO has the potential to become anything: a moon base with rockets and laser cannons, a pirate ship, a castle, or a city.

It's this imagination and improvisational spirit that's stayed with us as makers, so it's only appropriate that makers often turn to LEGO to bring life to their ideas. Grab some LEGO and a Raspberry Pi, and let's build something amazing!

Recommended PURCHASES

WANT TO MAKE SOME AWESOME LEGO PI BUILDS?
HERE'S THE INSIDE INFORMATION YOU NEED...



Price Varies

LEGO PICK A BRICK
Buy individual LEGO bricks
magpi.cc/2wOdXIS
Need some specific LEGO pieces? There are nearly 1,5[illegible] individual parts to choose from on the LEGO Pick A B[illegible] website, and prices start at a few pennies. A similar service can be found in bricks-and-mortar LEGO sto[illegible] It's a bit too easy to lose an hour of your life on here though, so be careful.

£3/$3

MICRO MOTOR LEGO ADAPTOR
LEGO wheel adaptor for motors
magpi.cc/2weTAkF
Want to use LEGO for the chassis of your creation? For robots and other moving objects, that can be tricky. This adaptor allows you to use micro metal gearmotors (**magpi.cc/2eYKHZR**) with LEGO axles to create supercharged LEGO machines.

LEGO MINDSTORMS EV3
LEGO robotics kit
magpi.cc/2xhMlgX
The EV3 is the starter kit for MINDSTORMS robotics projects. Combine the pieces in different ways to make your own amazing robots. It has been used with the BrickPi to make wonderful creations in the past, and is used in some of the projects on the following pages.

£300 /$350

BRICKPI
Connect LEGO MINDSTORMS robotics to your Raspberry Pi
magpi.cc/2weNxwt
Dexter Industries' BrickPi is an amazing piece of kit. It interacts with the popular LEGO MINDSTORMS kits to create robotic beasts, controlled via a Raspberry Pi. Several projects in this feature use BrickPi.

From $99/£75

LEGO DIGITAL DESIGNER
LEGO designer
magpi.cc/2wNPp2R
Want to see whether your design is feasible? Boot up Digital Designer and virtually build your next LEGO project. You can also use it to make handy, step-by-step instructions for your project.

FREE

BRICKUBER

BUILD A RUBIK'S CUBE-SOLVING ROBOT USING THE RASPBERRY PI AND LEGO

JOHN COLE & MATTHEW A. RICHARDSON

Two robot engineers with Dexter Industries. Matt builds robots in Michigan and John builds robots in Dubai. Both enjoy sand dunes, mountains, and playing with LEGO.
dexterindustries.com

PARTS LIST

BrickPi3 Base Kit
magpi.cc/2wyukZX

LEGO MINDSTORMS EV3
magpi.cc/2xhMlgX

Dexter Industries Power Battery Pack
magpi.cc/2xb7IzG

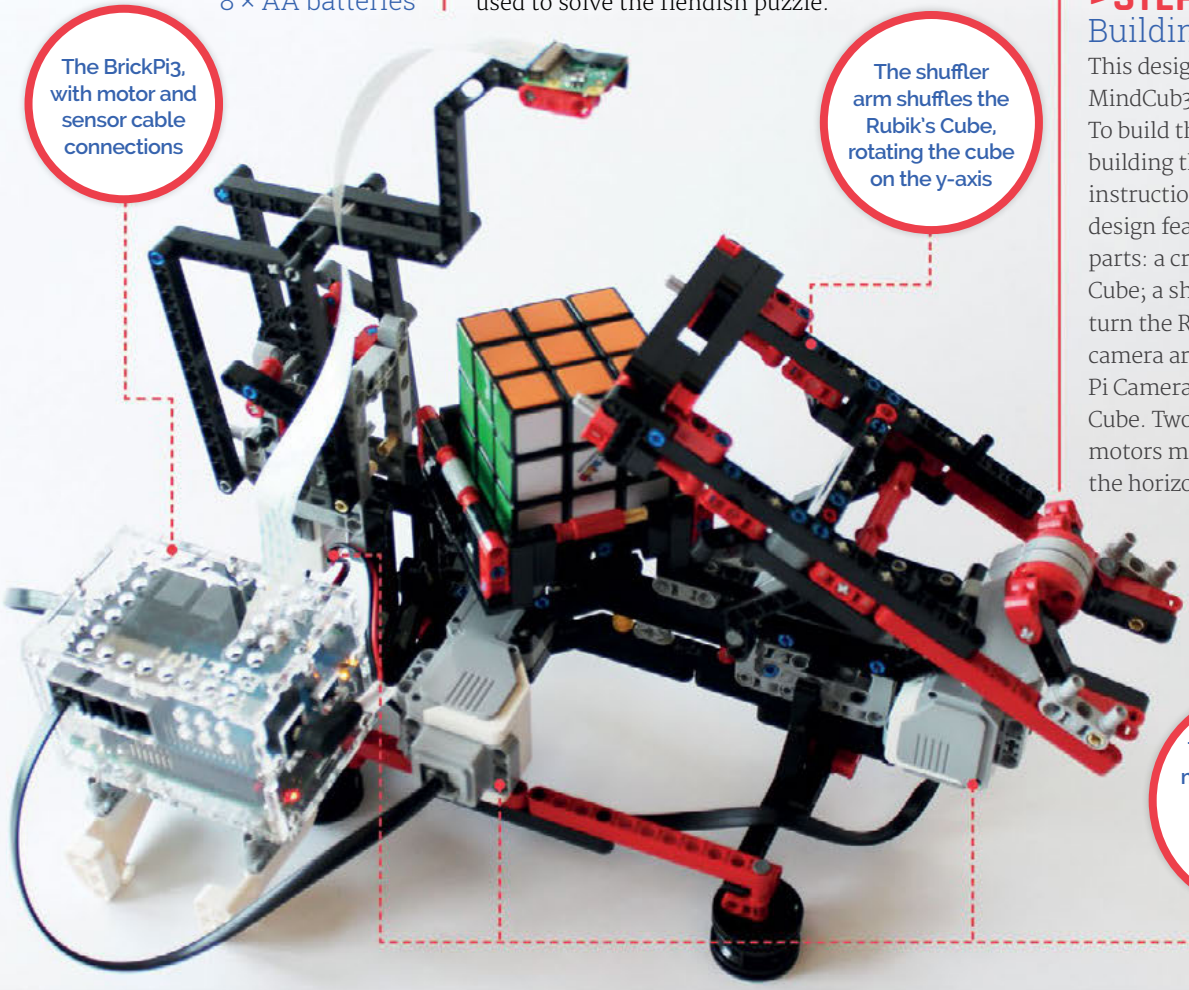
Rubik's Cube
magpi.cc/2xRaTcL

8 × AA batteries

The Rubik's Cube has recently begun to make a comeback. Solving it takes thought, effort, and skill – so why not let a robot do it? In this project, we take a Raspberry Pi, a BrickPi, and a LEGO MINDSTORMS set, and build a Rubik's Cube–solving robot. Simply place an unsolved Rubik's Cube in the solver, run the Python program, and your Rubik's Cube will be solved! The BrickPi3 takes the unsolved Rubik's Cube, while the Raspberry Pi takes a picture of each side of the cube using the Camera Module. This image is then used to solve the fiendish puzzle.

CODE

Filename: BricKuber.py
Language: Python
magpi.cc/2vYZPsT


The BrickPi3, with motor and sensor cable connections
The shuffler arm shuffles the Rubik's Cube, rotating the cube on the y-axis
Three different motors are used to manipulate and read the Rubik's Cube

>STEP-01 Building the solver

This design was inspired by the MindCub3r design for LEGO EV3. To build the BricKuber, start by building the MindCub3r using the instructions at **mindcuber.com**. The design features three major moving parts: a cradle to hold the Rubik's Cube; a shuffler arm that is used to turn the Rubik's Cube over; and a camera arm that holds a Raspberry Pi Camera Module over the Rubik's Cube. Two LEGO MINDSTORMS motors manipulate the Cube on the horizontal and vertical axes.

>STEP-02
Assemble the BrickPi3

Assemble the case and attach the BrickPi3, the Raspberry Pi, the Raspberry Pi Camera Module, and the battery pack. You can find assembly instructions for the BrickPi3 at **magpi.cc/2w30wBe**. Raspbian for Robots comes with most of the software you need already set up. We recommend using an 8GB SD card.

>STEP-03
Attach the BrickPi3

Now add the BrickPi3 to the LEGO assembly. Use the LEGO EV3 'wings' to support the BrickPi3 level with the BricKuber body. Add batteries to the power pack and attach it to the LEGO assembly. While programming, you can power the BrickPi3 via USB power to the Raspberry Pi. To move the motors, you will need to supply power with the Power Pack.

>STEP-04
Connect the motors to the BrickPi3

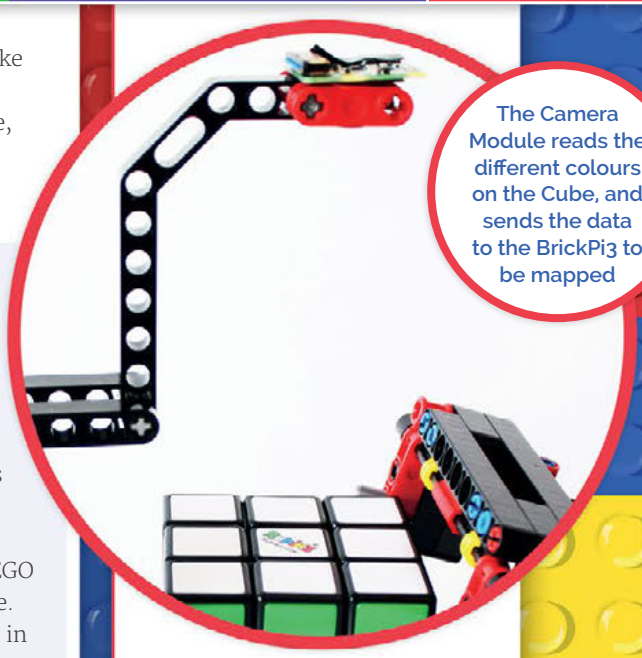
Attach the shuffler motor to motor port MD. Attach the cradle motor to the MA port on the BrickPi3. Attach the Camera Module motor to the MC port (this is the smaller, servo-like motor). The camera doesn't move while solving the Cube, but you may want to adjust its initial location using the motors.

>STEP-05
Attach the Raspberry Pi Camera Module

Using the LEGO camera support, attach the Camera Module. The small black lens should fit between the two LEGO beam supports. Secure the Camera Module to the LEGO supports using electrical tape. Make sure that the camera is in the correct position to capture the entire Rubik's Cube. You can take a test picture with the **raspistill** command: `raspistill -o cam.jpg`. Make sure the Cube is centred in the middle of the image.

>STEP-06
Prep the software

You can use any version of Raspbian, or Raspbian for Robots (the custom image that comes with the BrickPi3 already installed). If you are using Raspbian, you can install the BrickPi3 libraries:



The Camera Module reads the different colours on the Cube, and sends the data to the BrickPi3 to be mapped

```
sudo curl https://raw.
githubusercontent.com/
DexterInd/Raspbian_For_
Robots/master/upd_script/
fetch_brickpi3.sh | bash
```

This step will install all the libraries you need to run the BrickPi3 on Raspbian. Finally, install all project dependencies:

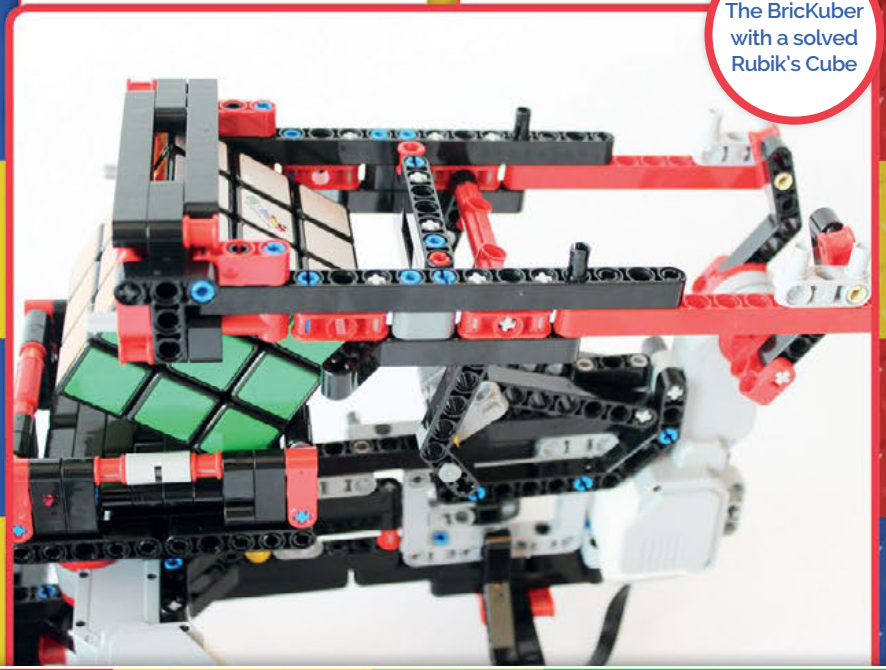
```
sudo curl https://raw.
githubusercontent.com/
DexterInd/BrickPi3/master/
Projects/BricKuber/install_
brickuber.sh | bash
```

>STEP-07
Solve a Rubik's Cube

Place an unsolved Rubik's Cube in the cradle. Use the command:

```
sudo python ~/Dexter/
BrickPi3/Projects/
BricKuber/BricKuber.py
```

The robot will turn the Cube to each face, and the camera will take six pictures – one of each side of the Cube. The Raspberry Pi will use the pictures to determine the Cube's configuration. The Cube configuration will be passed to the **kociemba** Python library to find an efficient solution. Finally, the robot will execute the moves to solve the Rubik's Cube!



The BricKuber with a solved Rubik's Cube

BrickPi BALANCEBOT

TWO WHEELS GOOD, FOUR WHEELS BAD: BUILD A BALANCING ROBOT WITH A RASPBERRY PI

PARTS LIST

BrickPi3 Base Kit
magpi.cc/2wyukZX

LEGO MINDSTORMS EV3
magpi.cc/2xhMlgX

Dexter Industries Power Battery Pack
magpi.cc/2xb7IzG

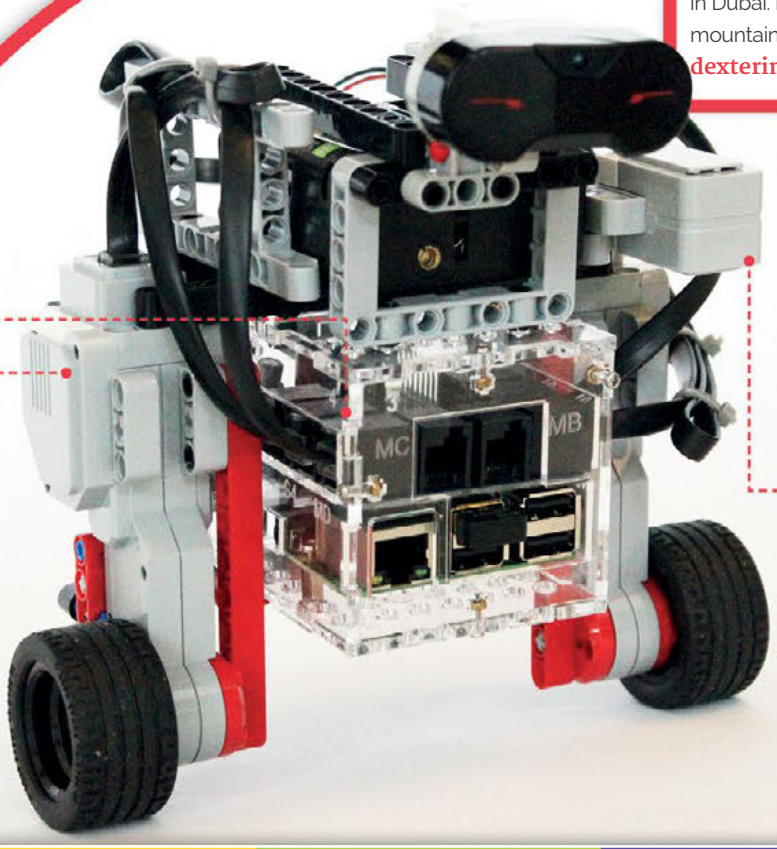
8 × AA batteries

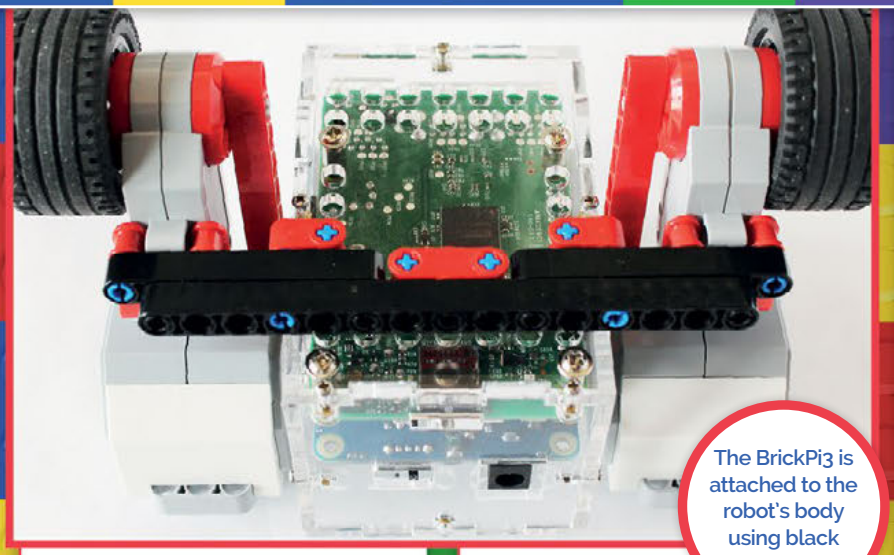
Are you tired of robots with three or more wheels? We have a solution! Using a pile of LEGO and a Raspberry Pi, you can have a robot wheeling around on two wheels in minutes. Our project uses the BrickPi3, which uses precise motor controls to create a robot that balances on two wheels. The project uses the LEGO gyroscope to detect whether the robot is falling over, and a Python program on the Raspberry Pi to control the motors with a PID (proportional–integral–derivative) algorithm.

To get going, simply build the robot, install the program, and run!

JOHN COLE & MATTHEW A. RICHARDSON

Two robot engineers with Dexter Industries. Matt builds robots in Michigan and John builds robots in Dubai. Both enjoy sand dunes, mountains, and playing with LEGO.
dexterindustries.com


The BrickPi3 and Raspberry Pi are the brains of the robot
The LEGO motors provide the power to the robot's wheels
The LEGO gyroscope sends data to the Raspberry Pi to keep the robot balanced
MC
MB



The BrickPi3 is attached to the robot's body using black LEGO pins

CODE

Filename: BalanceBot.py
Language: Python
magpi.cc/2vZHrQr

>STEP-01
Assemble the BrickPi3 and the Raspberry Pi

First, assemble the case, the BrickPi3, and the Raspberry Pi. You can find assembly instructions for the BrickPi3 at **magpi.cc/2w30wBe**. We recommend using Raspbian for Robots, a version of Raspbian that comes with the BrickPi3 software already installed. You can also use your own version of Raspbian, and run our install script (**magpi.cc/2gOjPbT**) to create the BrickPi3 setup. For this project you will also need eight AA batteries.

>STEP-02
Build the BalanceBot

This robot design is very simple and only uses parts that come with the MINDSTORMS kit. You can find detailed instructions, in LEGO Digital Designer format, and in HTML, on GitHub: **magpi.cc/2vZHrQr**. You will need two EV3 motors (with the red hubs and grey bodies). Check that the IR controller that came with the LEGO kit is working, and that the batteries are fully charged.

>STEP-03
Attach the BrickPi3

Add the BrickPi3 to the LEGO assembly. The acrylic body is attached using the black LEGO pins that come with the LEGO kit. Place the pins into the body of the BrickPi3 first, then attach the BrickPi3 to the LEGO BalanceBot. Place the batteries inside the battery box, and connect that to the BrickPi3.

>STEP-04
Connect the motors and sensors to the BrickPi3

The left and right motors are connected to ports MA and MD on the BrickPi3. You can find the port labels etched next to the ports on the BrickPi3 case. The cables should not cross each other. Choose a set of wheels to attach to the motors. The code that comes with the project is designed to work with the black low-profile racing wheels that come with the LEGO kit, but you can adjust the variables in the Python program to fit any compatible wheel set.

>STEP-05
Connect the sensors to the BrickPi3

This project uses the LEGO infrared sensor and the LEGO gyroscope. The gyroscope will read the rate at which the BalanceBot is falling over, and adjust the motors. This sensor is connected to BrickPi3 sensor port 4. This project uses the EV3 infrared sensor to receive control commands: use the infrared beacon to command the robot to roll forward, backward, and turn. The EV3 infrared sensor is attached to BrickPi3 sensor port 1. Be sure to set the infrared channel on the EV3 infrared beacon to channel 1.

>STEP-06
Prepare the software

You can use any version of Raspbian, or Raspbian for Robots (the custom image that comes with the BrickPi3 already installed). If you are using Raspbian, you can install the BrickPi3 libraries:

```
sudo curl https://raw.
githubusercontent.com/
DexterInd/Raspbian_For_
Robots/master/upd_script/
fetch_brickpi3.sh | bash
```

This will install all the libraries you need to run the BrickPi3 on Raspbian.

>STEP-07
Run the program

Power up your BrickPi3 and connect it to your Raspberry Pi. In the command line, enter:

```
sudo python ~/Dexter/
BrickPi3/Projects/
BalanceBot/BalanceBot.py
```

After starting the program, you will be prompted to set the robot upright. Balance the BalanceBot as well as you can, standing upright, and almost balancing on its own. In the Terminal, you will be prompted to press a button on the IR remote control to start the balancing process. When you press the button, your robot should begin to balance on two wheels on its own!

Build A RETRO CONSOLE CASE

DON'T LIKE THE IDEA OF 3D-PRINTING A CASE? HERE'S HOW TO MAKE A LEGO CASE!

PARTS LIST

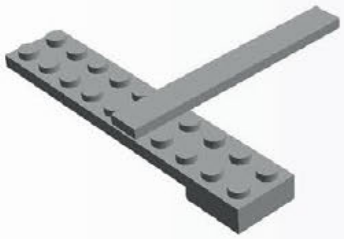
LEGO
magpi.cc/nespilego

RetroPie
retropie.org.uk

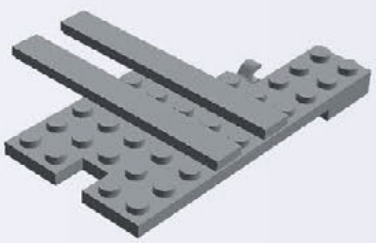
USB game controller

Want to make a retro console with your Raspberry Pi? There are several tutorials online, but many of them use 3D-printed cases. Building with LEGO is much more fun than watching a 3D printer whirr away, so here's how to make a NES-like Pi case out of LEGO.

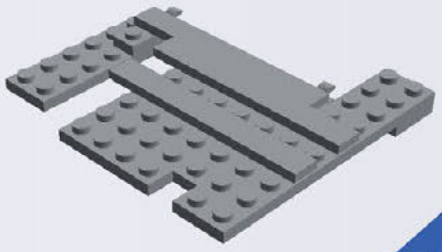
>STEP-01



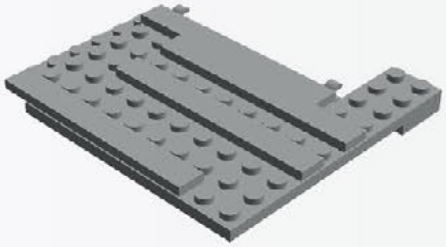
>STEP-02



>STEP-03



>STEP-04



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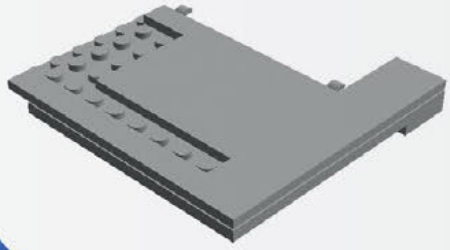

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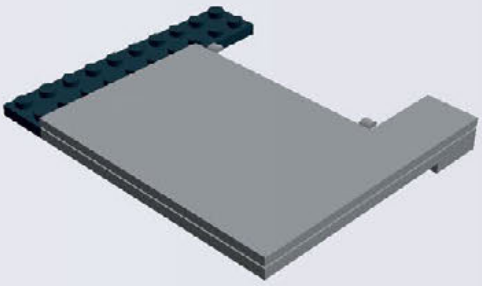

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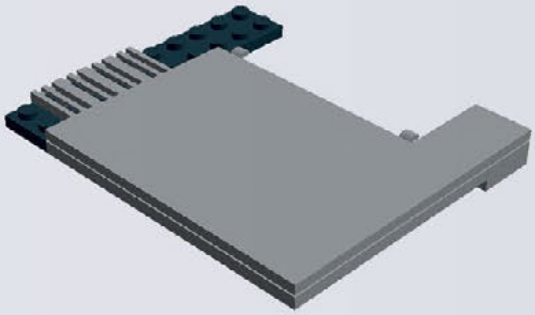
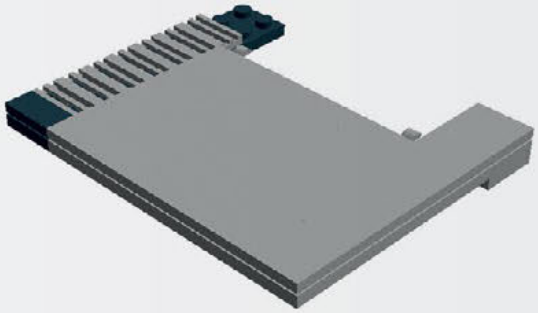
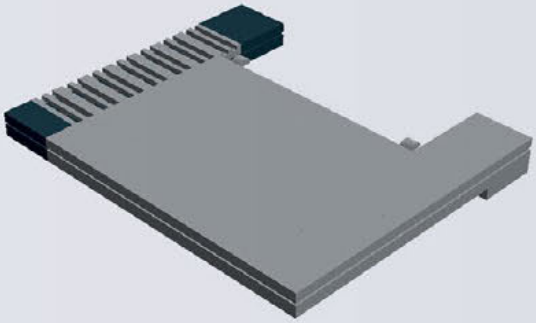


>STEP-08

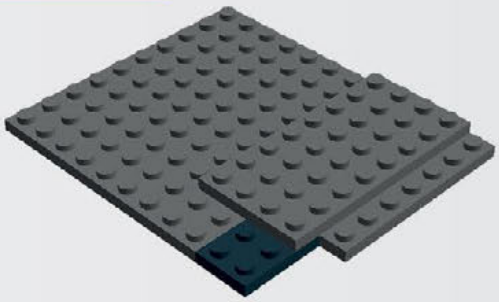


>STEP-09

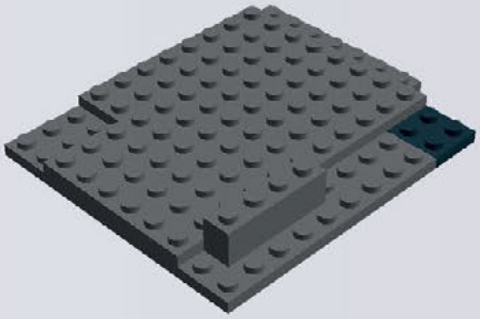


>STEP-10

>STEP-11



>STEP-12



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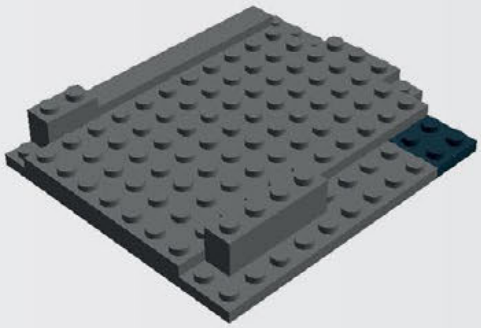
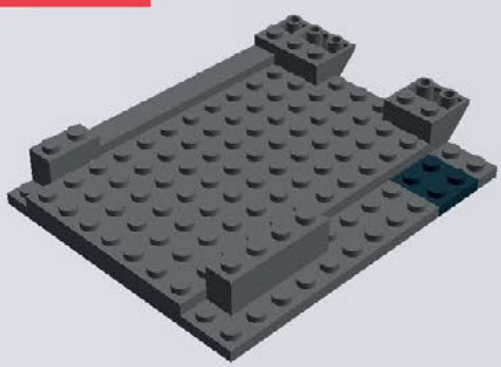
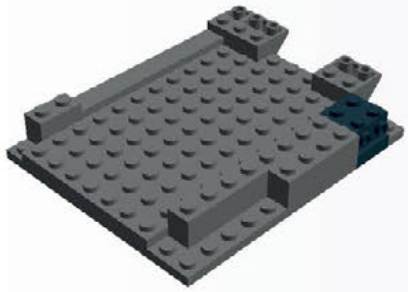


>STEP-14



>STEP-15



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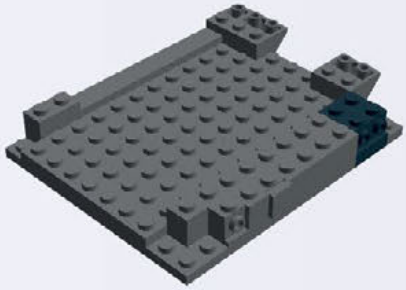

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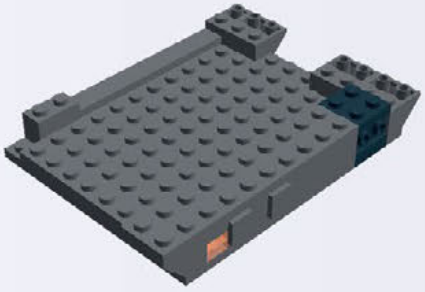

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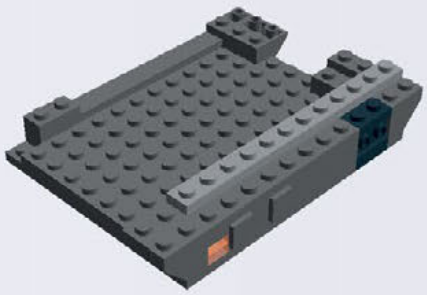

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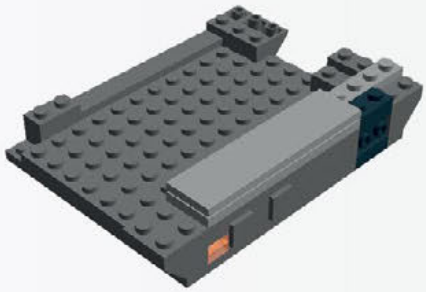

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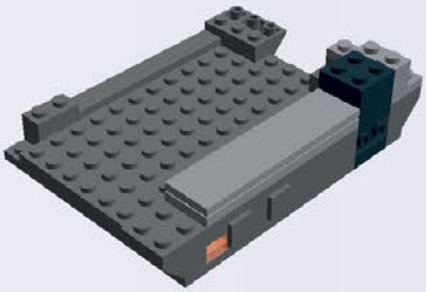

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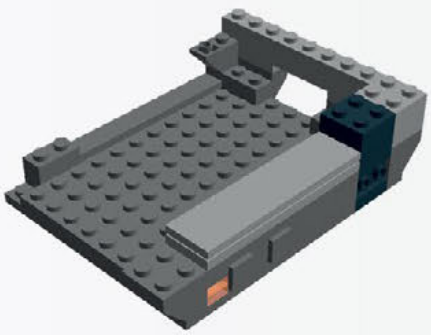

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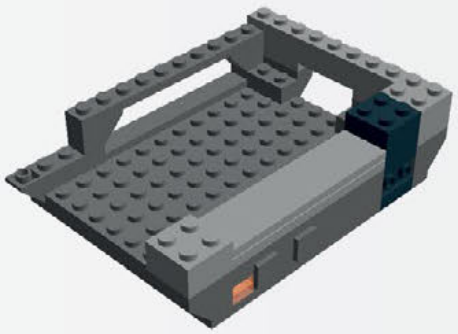

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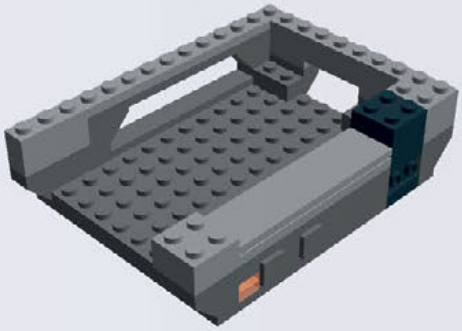

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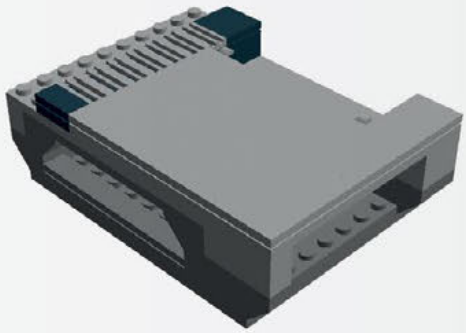

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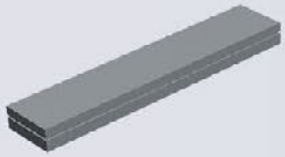

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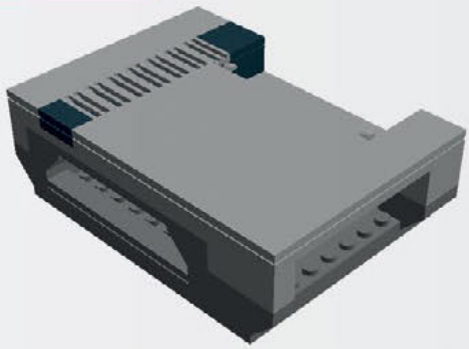

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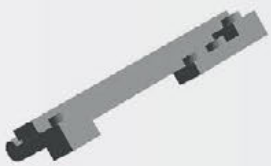

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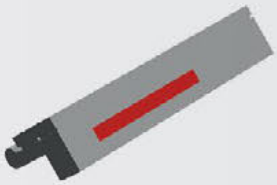

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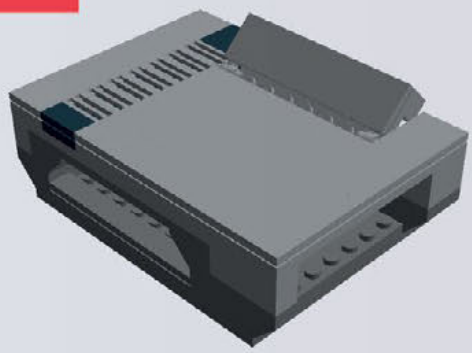


SETTING UP RETROPIE

We've covered setting up RetroPie in the magazine before, most recently in issue 55's PiGRRL Big Build (**magpi.cc/2fczrWL**). The process is extremely easy, and RetroPie guides you through the setup step by step once you've installed it on an SD card.

Inspiring LEGO PROJECTS

INCREDIBLE PROJECTS AND IDEAS FROM THE RASPBERRY PI COMMUNITY

We love seeing your amazing LEGO projects. Young or old, it's a great way to really fire up your imagination and make something amazing. Here are some of our favourite builds from around the globe – we hope they inspire you to make something spectacular!

INTERNET OF LEGO

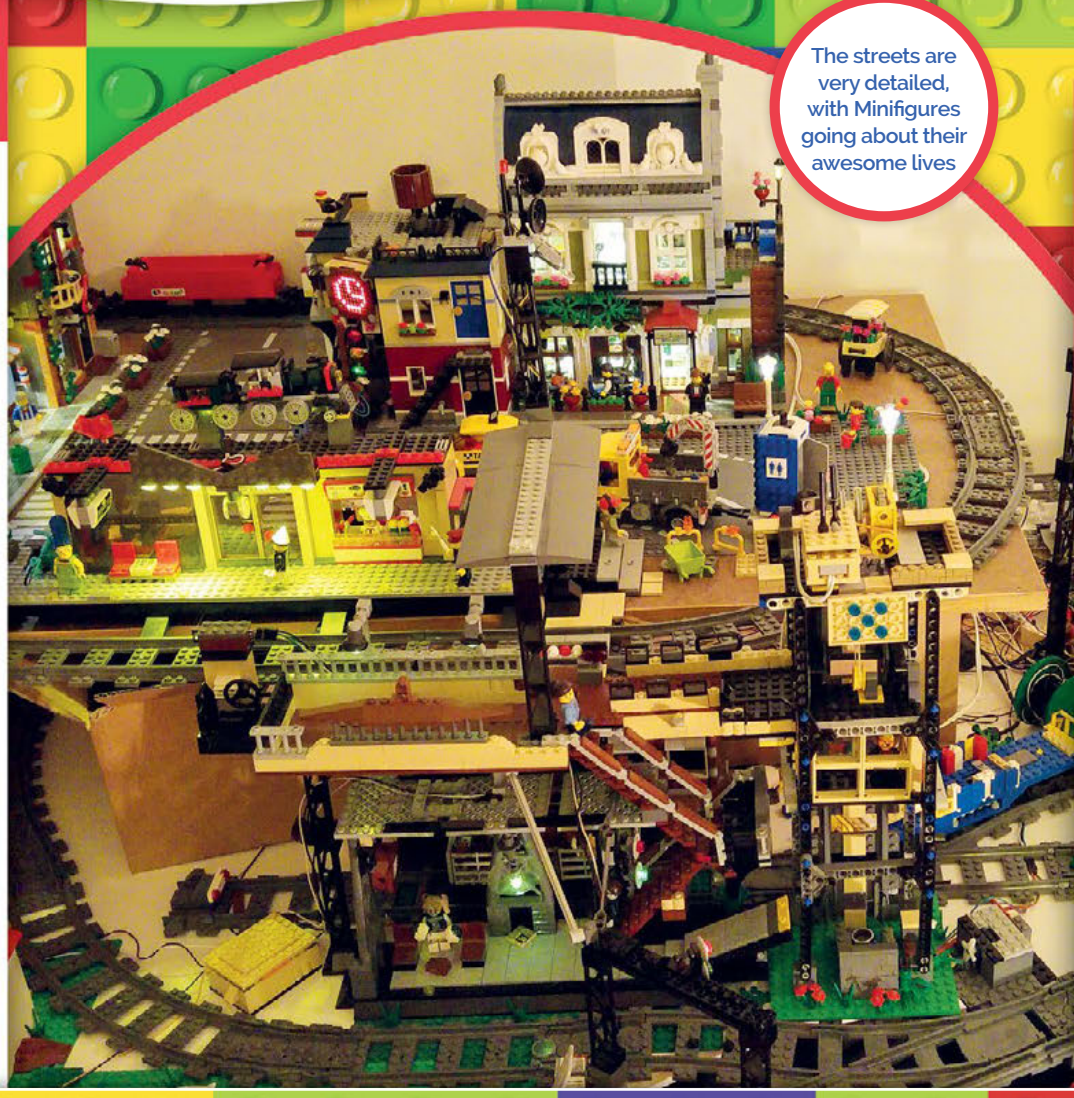
URL
internetoflego.com

MAKER
Cory Guynn

We've featured the Internet of LEGO in *The MagPi* before, but we always think it's worth revisiting. It's an incredible, ongoing project that creator Cory Guynn uses to teach himself IoT by developing a working LEGO city.

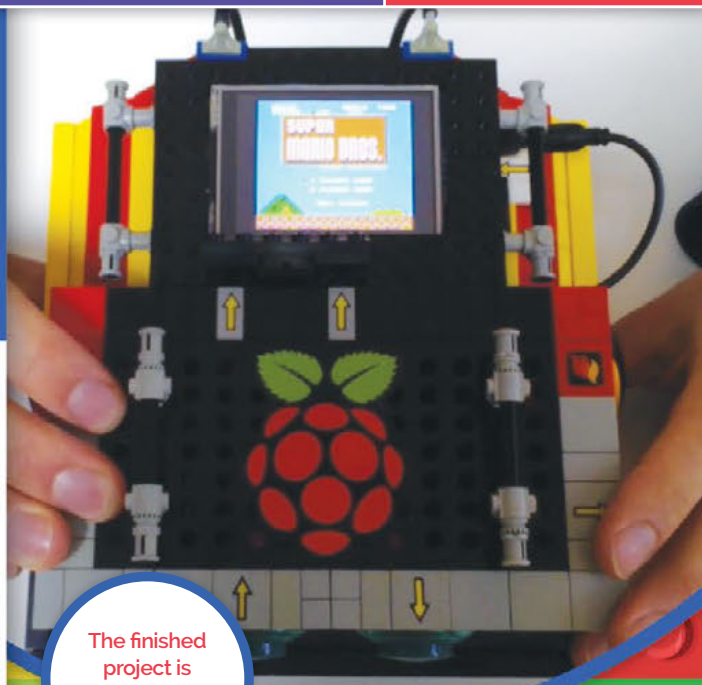
A Raspberry Pi controls the city, aided by microcontrollers and other Pis hidden in the different structures.

"I grew up playing with LEGO bricks and model trains," Cory told us, "which taught me about construction and electronics, and allowed me to be creative. The use of LEGO also allows me to represent a city or build prototype systems easily. Plus, it gives me an excuse to buy a bunch of LEGO bricks in my thirties."



The streets are very detailed, with Minifigures going about their awesome lives

LEGO ARCADE MACHINE



The finished project is lovely and very eye-catching

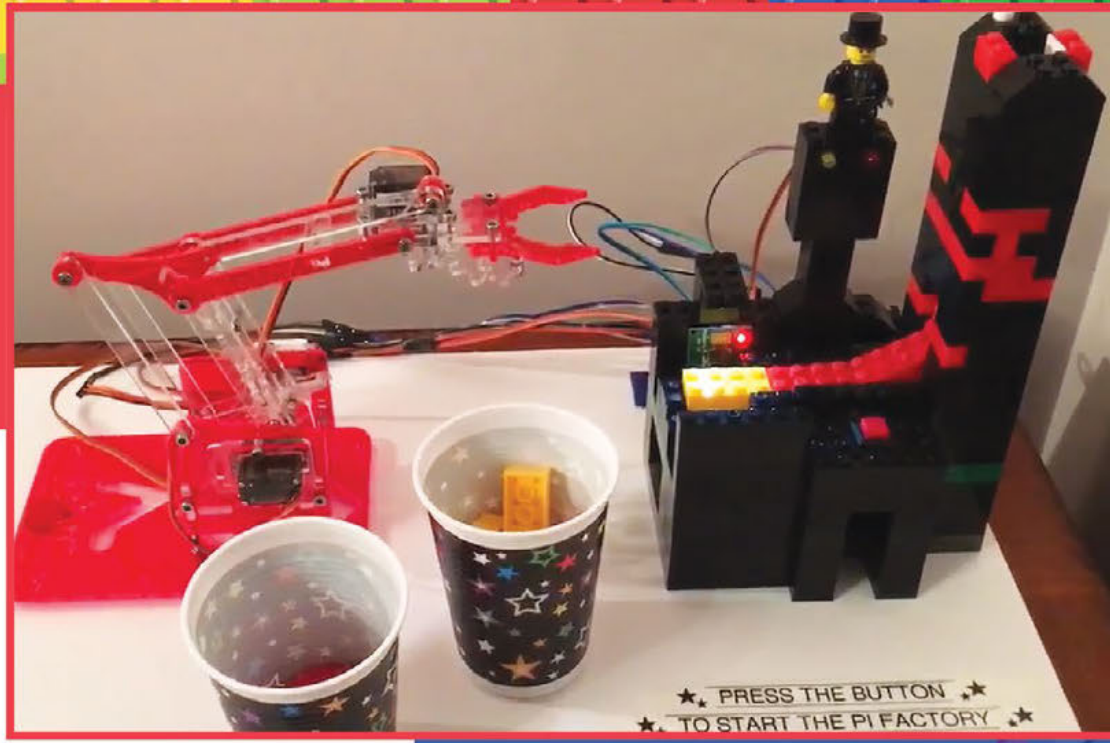
URL
magpi.cc/2wbUpuz

MAKER
Tobias Hübner

Tobias Hübner loves to combine LEGO and Raspberry Pi. He's made many cases out of LEGO, based on or using official LEGO kits that he's modified for purpose. With some projects, he goes a little further.

While it works as a case for the Raspberry Pi, this arcade machine also has buttons and a display built into the model, so that works as a proper tabletop arcade machine! It's a one-player device, and Tobias describes it as a LEGO Game Boy. You can find out how it fits into the Raspberry Pi computer lab at Tobias's school on his website: **magpi.cc/2wKsepX**.

LEGO SORTING ROBOT



URL
magpi.cc/2wbmDpb

MAKER
David Pride

Playing with LEGO is fun, but what do you do when you need to clear up afterwards? Either you chuck all the pieces into a box, or you build a LEGO robot to sort the bricks and tidy them away neatly.

David Pride opted for the latter, and his robot uses LEGO, a Raspberry Pi, and a MeArm to sort individual LEGO bricks by colour. It works by feeding LEGO bricks down a chute, where the Raspberry Pi then takes a photo of the brick. It determines what colour the brick is, then the MeArm robot arm swings around, picks it up, and puts it in the correct container.

Of course, the time it took to build and program the arm could have been used to put the LEGO away to begin with.

SEND US YOUR PROJECTS!

Have you made a LEGO Raspberry Pi project? Has this feature inspired you to create something incredible? Send photos to us on Twitter (**@TheMagPi**) or via email (**magpi@raspberrypi.org**) – we'd love to see it!

WALL-E

URL
magpi.cc/2wKb30E

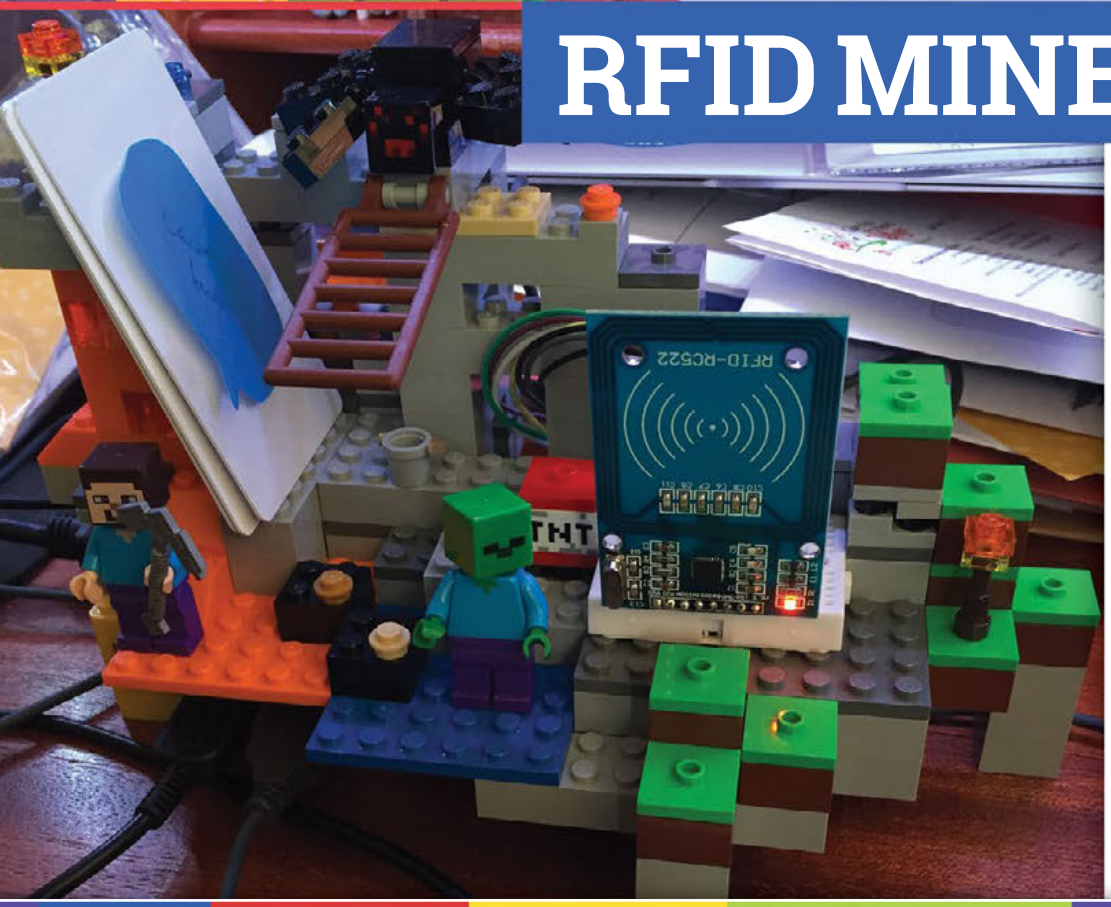
MAKER
Tobias Hübner

The LEGO WALL-E kit is lovely – the simple, mechanical design of WALL-E lends itself to translation into blocky LEGO. However, WALL-E is a robot, and this kit doesn't include any robotics – so Tobias added some.

This WALL-E build uses a PicoBorg Reverse (**magpi.cc/2wUzmk1**) and motors to move it around, and it's all controlled via a Wii Remote and a Bluetooth dongle on the Raspberry Pi. The best part is that because the WALL-E kit has a cavity in the centre, you can store most of the electronics inside him! Bonus.

The Raspberry Pi is hidden away inside WALL-E

RFID MINECRAFT



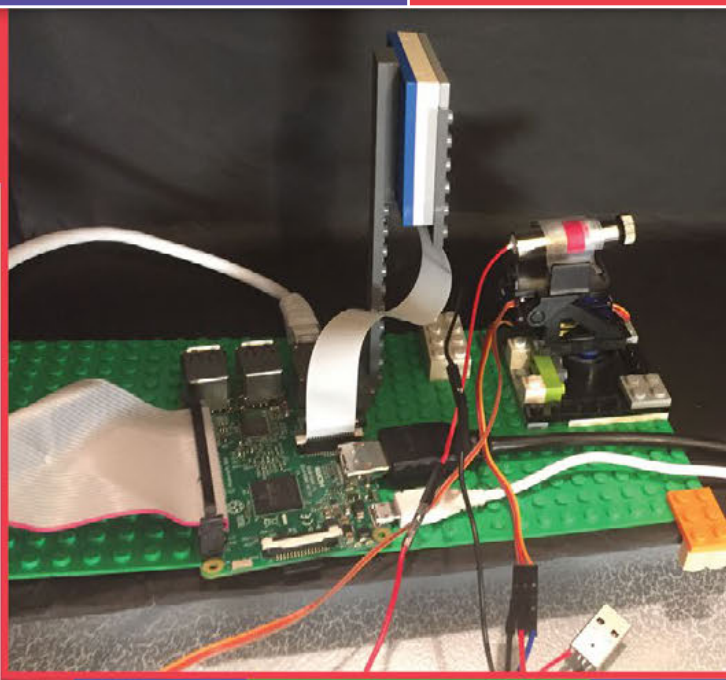
URL
magpi.cc/2wdVdPu

MAKER
Spencer Organ

Using a physical LEGO Minecraft build, you scan RFID cards to send signals to a Raspberry Pi, which then builds a specific object in Minecraft. This project is a beautiful melding of physical and virtual worlds, which is something we love.

It was built for Raspberry Pi's fourth birthday party, and Spencer describes it as a demo of how children with limited motor skills can still play Minecraft. The cards allow you to build a house, create a waterfall, create a lava version of the waterfall, and play a mini game involving TNT.

LEGO LASER



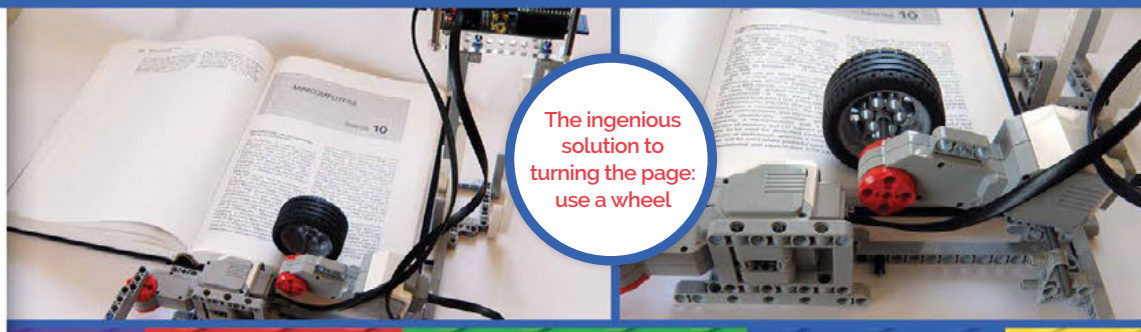
URL
magpi.cc/2wNyiOP

MAKER
Elijah Horland

There's a clichéd joke in TV shows about smart people. As a child, any smart character will have built something unbelievably advanced for a school science fair.

Elijah is a smart schoolchild who is currently living this fantasy. For his science fair, he created a LEGO laser gun. More accurately, it's a maser, which uses microwaves instead of light, but it is still powerful enough to burn patterns into wooden boards. He was awarded full marks, and the rest of the kids voted it as their favourite project. We wonder whether this was due to the high quality of the build, or the fact that Elijah is now armed with a working laser gun…

BRICKPI BOOKREADER 2



The ingenious solution to turning the page: use a wheel

URL
magpi.cc/2welg90

MAKER
Dexter Industries

Earlier this year, the great folks at Dexter Industries (who made the Rubik's Cube solver on page 18 and the BalanceBot on page 20) created a Pi-powered LEGO robot that could read a Kindle. It uses the Pi Camera Module to take a picture, and then uses text-to-speech to read the text aloud before swiping across the screen to turn the page.

While that was cool, what's even cooler is to build a robot that works with a real book, and so the Bookreader 2 was created. It uses a wheel to turn the page, takes a picture, and reads it to you. We wonder if any young kids would like a robot to read them a bedtime story while we watch *Black Sails*…

HOME ALONE HOUSE

URL
magpi.cc/2wNikE5

MAKER
Christopher Hill

This isn't a house full of traps to slow down a set of Minifigure burglars, however cool it might be to wallop one with a LEGO brick on a piece of string. Instead, this house is a recreation of the scene where Kevin manages to create the illusion of a party in his house through an elaborate, Heath Robinson setup.

The project uses sensors to trigger the actions of automated party-goers in an elaborate LEGO setup. We love the reference and the ingenuity behind making it in LEGO, so we feel it definitely deserves a place here!

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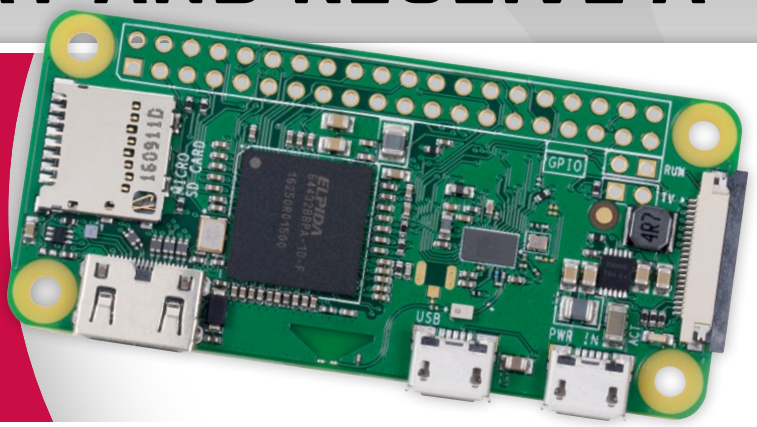

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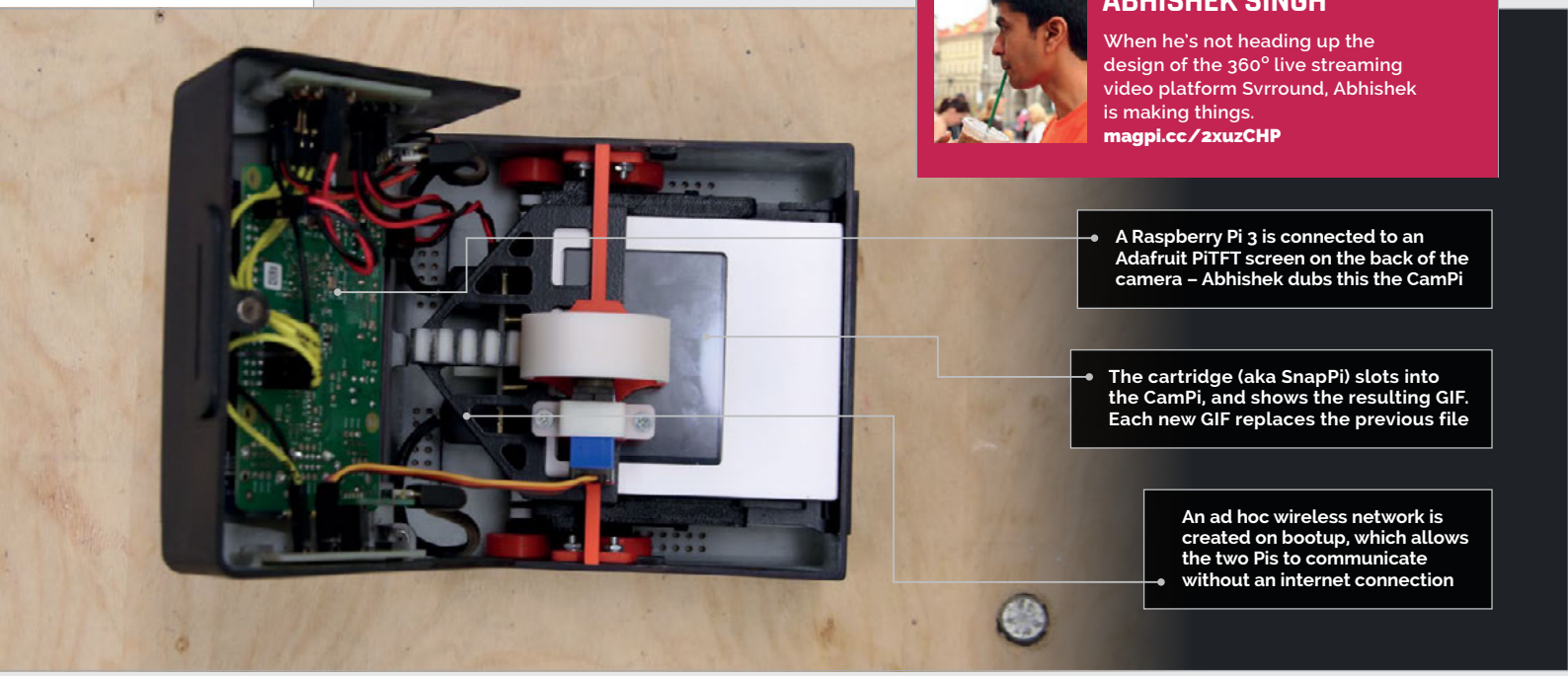
ABHISHEK SINGH

When he's not heading up the design of the 360° live streaming video platform Svrround, Abhishek is making things.
magpi.cc/2xuzCHP


A Raspberry Pi 3 is connected to an Adafruit PiTFT screen on the back of the camera – Abhishek dubs this the CamPi
The cartridge (aka SnapPi) slots into the CamPi, and shows the resulting GIF. Each new GIF replaces the previous file
An ad hoc wireless network is created on bootup, which allows the two Pis to communicate without an internet connection

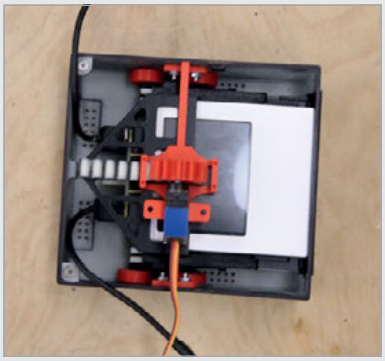
Quick Facts

- The Instagif is inspired by the Polaroid OneStep SX-70
- A Pi 3 and Pi Zero W are used
- Instagif takes three-second GIFs
- The GIF fades into view like a Polaroid image
- It took four weeks to design and build

INSTAGIF NEXTSTEP

Ever wished your instant camera could cope with moving images? Abhishek Singh has the answer!

Before digital cameras became popular, photographers would use film to capture their images. They'd take a set number of shots and send their snaps away to be processed, but then they'd have to wait days – or even weeks – to see the results.



Right The cartridge looks like a Polaroid picture, and is ejected using a rack-and-pinion mechanism

Instant cameras were invented to speed up this process. Polaroid became famous for making cameras that could print out a paper-based photo in seconds. A few shakes, and the image would appear as if by magic. While instant cameras have fallen out of favour with the advent of digital cameras, the appeal of the concept endures.

Instant update

Abhishek Singh certainly likes it. Motivated by the desire to build something physical, and spurred on by his love of animated GIFs ("my earlier projects have revolved around them as well," he tells us), he has harnessed the power of the Raspberry Pi and moved the instant camera into the 21st century. By inserting a cartridge with a tiny screen into his cool retro-inspired invention, you can record a GIF, wait for the cartridge to pop out and, after a few seconds, watch and enjoy the mini-video. What's more, the device looks just like a vintage Polaroid OneStep camera.

"Something about holding a moving image sounded intriguing," Abhishek explains. "It's instantly relatable, and it has the unique and exciting interaction of a physical image coming out immediately that you can hand to a person. I wanted to recreate the experience of a Polaroid in a new way."

SNAP HAPPY

>STEP-01
Inserting the components

There wasn't much space for the components in this build. Abhishek fitted a 2.8-inch PiTFT screen into the cartridge, and he chose a 400 mAh LiPo battery to power the cartridge when it's ejected.

>STEP-02
Using a Pi Zero

A Raspberry Pi Zero W was soldered to the screen. Abhishek removed the header pins from the screen, sanded down the Pi's micro USB ports and PCB, and removed the top casing from the HDMI port.

>STEP-03
Charging up

The cartridge is charged by a PowerBoost 1000C charger in the camera. Python and Node scripts run in the camera, handling the connections and camera control. Clicking the button starts and stops the GIF recordings.

Instant design

To begin with, Abhishek sketched out his plan on paper, before turning to Autodesk Fusion 360. His design had to take two units into account: the camera (dubbed CamPi) and the cartridge (SnapPi). To produce the camera, he used a Raspberry Pi Camera Module, an iPhone lens, and an 8GB SD card. The cartridge uses a 2.8-inch screen and another 8GB SD card. A Raspberry Pi Zero W was fitted into the cartridge, and a Raspberry Pi 3 was used in the camera.

"I had to think and visualise ways of assembling the thing, and look at how it would be disassembled if I had to troubleshoot something," explains Abhishek. "I needed to consider how everything would fit together and be placed to minimise the size. A lot had to be done to conserve space, and I mutilated both of the Raspberry Pis I used in the project quite a bit, but that's what made using them so great."

The Pis were trimmed and sanded. The Ethernet port and a dual USB port were removed from the Raspberry Pi 3, so the mounting holes could be used for the camera chassis. Four circuits were produced to manage the wiring and distribute power, and Abhishek made his own USB cables. Major issues included finding a suitable way of ejecting the cartridge from the camera (Abhishek chose a rack-and-pinion mechanism with wheels to eliminate friction), and solving a wide-angle problem. "But I like the community the Pi has," he says. "A solution to the problem you are facing is probably out there somewhere."

> "For me, it was not so much about the learning curve being steep as about finding creative solutions"

Instant success

It helped that he split the project into small, doable chunks. "It meant I could go through an individual process of iteration, testing and refinement," he adds. Indeed, once the working pieces were ready, it was simply a case of assembling them into the printed plastic components that made up both the camera and the cartridge. Finally, Abhishek could point the camera, press the record button, and watch as the cartridge popped out and the GIF appeared.

Was it worth it? "The reaction has been super-positive," he says. "For me, it was not so much about the learning curve being steep as about finding creative solutions to the problems that arise every step of the way."

The parts were printed using a Project 7000 SLA printer, before being sanded and painted

MARK WILLIAMS

Mark is a co-founder of Ozzmaker, which makes and sells Pi add-ons in Australia – including the BerryGPS-IMU unit used in this project.
ozzmaker.com

PI CAMERA CAP

Rather than keeping it under his hat, **Mark Williams** reveals how he made his GPS-equipped camera cap

Quick Facts

- The build details are at **magpi.cc/2xhKuZq**
- A BerryGPS-IMU provides geotag data
- A GPS fix takes 10–15 minutes
- The main software is a Bash script
- The data can be used to map your route

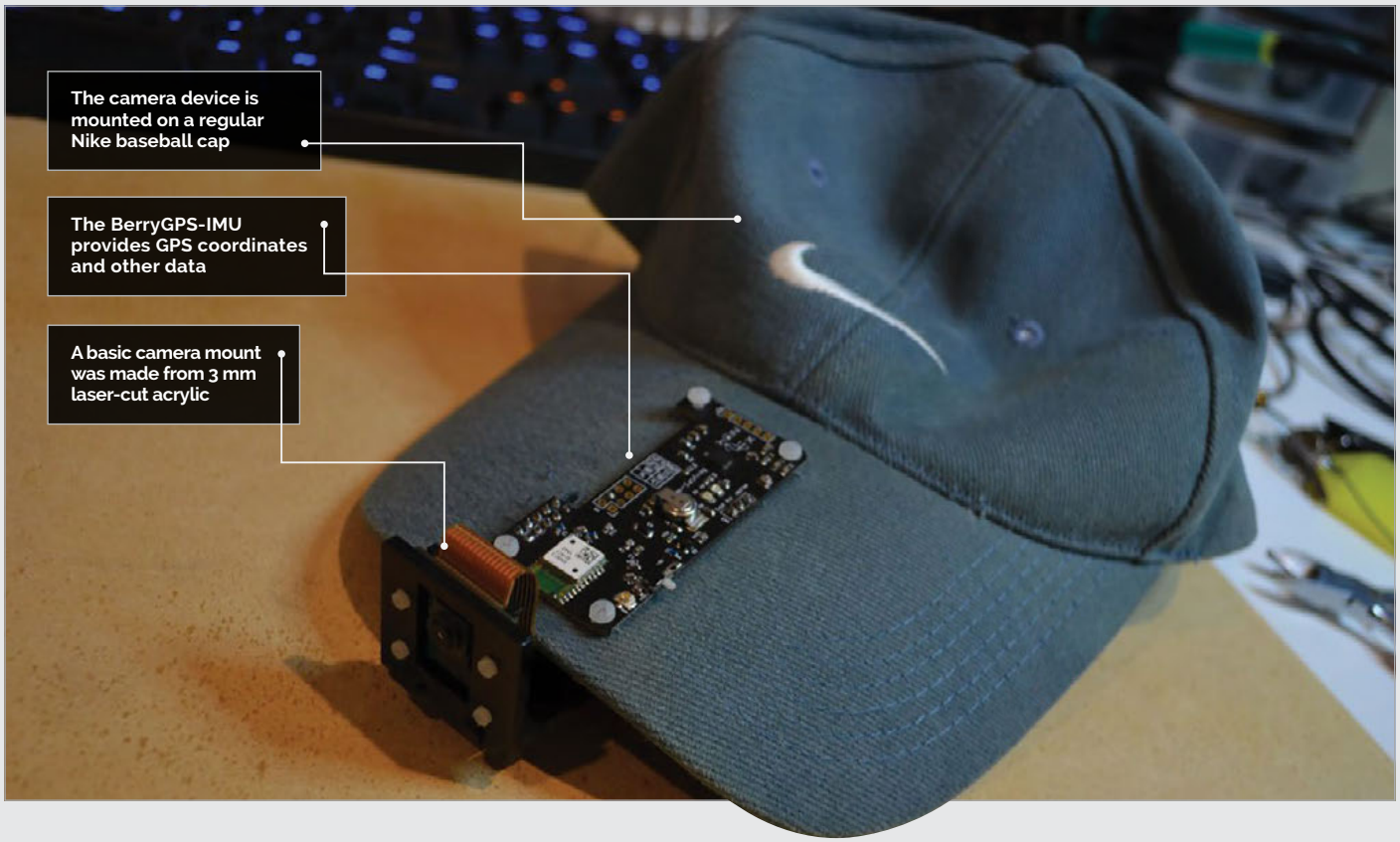
Who needs Google Glass to produce a first-person visual record of their day, when you can make a DIY camera cap? That's just what Mark Williams did, using an old Nike baseball cap, a Raspberry Pi Zero, and a Camera Module. Not only that, but he's added one of his own BerryGPS-IMU boards, created with his colleagues at Ozzmaker.

The BerryGPS-IMU obtains GPS coordinates to geotag the photos taken, as well as logging the altitude (with a pressure sensor) and 'attitude' – pitch, yaw, and roll – of the camera, to enable images to be subsequently corrected to appear perfectly horizontal.

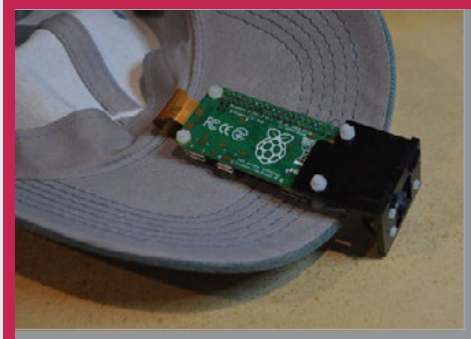
"I saw an old article about recording GPS, pitch and roll angles of photos and I thought the Pi Zero with a BerryGPS-IMU could pull this off nicely," explains Mark. "Originally I was going to place it in the top pocket of a shirt. However, placing it in a cap would give you a wider range to take photos in: just look and shoot!"

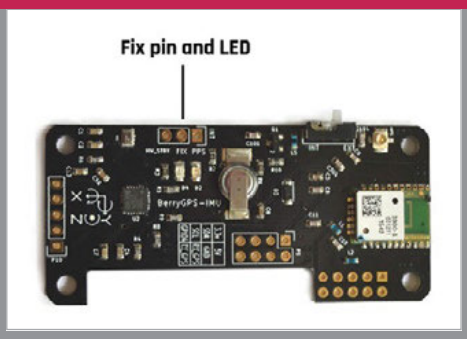
Building and coding

While embedding the Pi Zero and BerryGPS-IMU in the cap was very quick and easy, it took Mark about a week to come up with the main Bash script that calls Python code and other tools to perform various functions. "My thinking was that I already have Python code to track GPS and read the IMU. **Raspistill** was used to take photos and **Exiftool** was used to edit EXIF data in the photos. I just needed to put it all together."


The camera device is mounted on a regular Nike baseball cap
The BerryGPS-IMU provides GPS coordinates and other data
A basic camera mount was made from 3 mm laser-cut acrylic

PUT A CAMERA IN YOUR CAP





>STEP-01
Customise a cap
The BerryGPS-IMU is placed on top of the cap's visor, with the Pi Zero underneath, connected via holes. A laser-cut acrylic mount holds the Camera Module.

>STEP-02
Connect GPS fix pin
To detect whether a satellite fix has been obtained by the BerryGPS-IMU board, its fix pin must be connected to a GPIO pin on the Raspberry Pi.

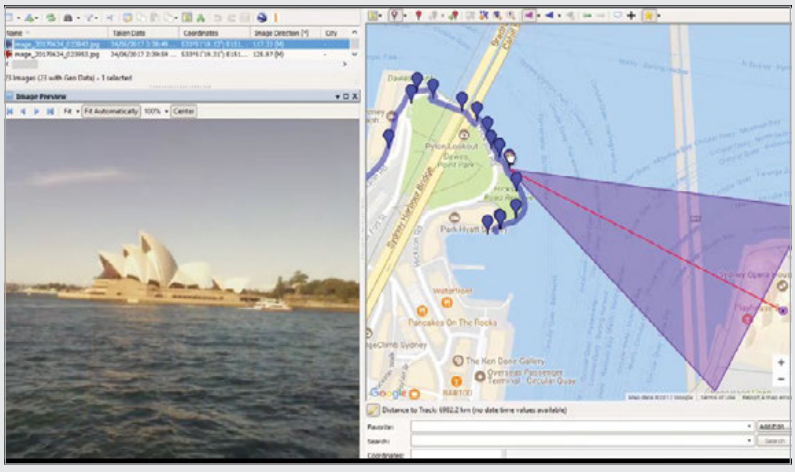
>STEP-03
Power it up
The Camera Cap is powered by a small 3.6 V LiPo battery, connected to the Pi via an Adafruit PowerBoost 1000. It delivers 1.5 hours of use.

Mark informs us that obtaining a GPS fix typically takes 10 to 15 minutes. "As long as the BerryGPS-IMU module has access to the sky, no antenna is needed." He has tested the fix, it performed well. Most of the issues I had were with the script not starting up correctly when the Raspberry Pi was powered on. I also had to fiddle with the settings for taking images.

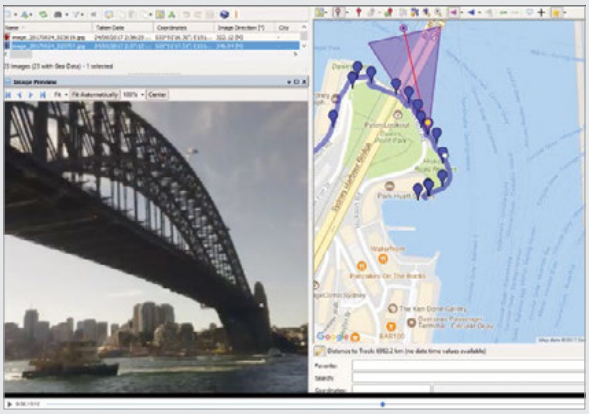
> "Once I had a GPS fix, it performed well. Most of the issues I had were with the script"

Pi Camera Cap outside on a few occasions, including a stroll around Sydney Harbour, taking pictures of the famous bridge and opera house. "Once I had a GPS

At first I tried to take a photo every five seconds by removing the delay from **raspistill**, but this resulted in the Pi camera not being able to focus."



Above Software such as GeoSetter (Windows) can be used to show a map location, and even the camera direction, for each photo taken



Above Mark wore the cap on a stroll around Sydney Harbour, taking photos of landmarks such as the famous 'coat hanger' bridge

Photographic record

The cap is powered by a small 3.6 V LiPo battery. Connected to the Pi Zero via an Adafruit PowerBoost 1000, it can power the device for up to 1.5 hours. By default, the camera is set to take a photo every two minutes, but this can easily be altered. "I would say time-lapse is possible; the lowest interval I had where the image quality was still good was 20 seconds." There's also the possibility of shooting video.

Mark says he has received some strange stares while wearing the cap in public. "I think the outward-facing Pi camera and the size of its PCB makes it obvious something strange is going on with my cap." As for needing to visit the bathroom, he advises it's "best just to take the cap off!"

ROBERTO TYLEY

An open-source enthusiast, Roberto develops software for The Guardian, and authored the BFG Repo-Cleaner.
magpi.cc/2wVeHNE

MESMERIC MIRROR

Looking to brighten a dark bedroom, **Roberto Tyley** decided to cast fresh light on the idea of a motion-sensing illuminated mirror

Quick Facts

- It took nine months to build
- The laser was £139 and the project cost £250
- Roberto used an eyeball-safe, low-power Class I laser
- A Bluefruit EZ-Key acts as the on/off switch
- Find the Python code at **magpi.cc/2wURUBy**

On reflection, he could have just bought a lamp. But after Roberto Tyley stood on one too many of his children's toys in the dark corners of his bedroom, and decided it was time for some additional light, he was hit by a flash of inspiration.

What better way of illuminating the room, he mused, than a full-length portrait mirror that would shine brightly whenever anyone wandered by? One with individually controllable LED lighting that would directly respond whenever someone posed in front of it, perhaps? As light-bulb moments go, he admits it was certainly high on the wacky scale.

But Roberto saw the potential for both practicality and fun. "The idea was to have a mirror that would know if my children were waving their hands around," he explains. "I wanted the lights to move and sparkle around their fingers as they did so."

Pi-powered

Roberto's first decision was to put a Raspberry Pi at the heart of the build. He had only ever used the computer once before, to create a video demonstrating the speed of a tool he'd written to clean Git

This shelf of electronics effortlessly slides into the unit, connecting via a Multi-Beam XLE power connector
Roberto didn't want to use an obtrusive always-on video camera, so he used a laser rangefinder instead
The Adafruit DotStar LEDs use a simple wiring system, with four wires controlling the whole strip

> My children love it, and they show it off to their friends when they come round

repositories. He liked the fact that the Pi was a fully specced Linux platform. "It meant I could use the tools and languages I was familiar with," he says.

His next step was to research the best lighting, and he eventually chose Adafruit's DotStar Warm White LED strips. "They are more expensive than simple strips, but they use a pretty straightforward wiring system," Roberto explains. "Adafruit also supplies a nice Python library to control the strip from the Pi."

Motion sensing

From there, he looked for a way of detecting the presence of a person, before hitting on the idea of a laser rangefinder. "It occurred to me that if I had a laser rangefinder pointing straight down from the top to the bottom of the mirror, in the same axis as the LEDs, it could sense how high up anything was," he continues.

This would allow the LEDs to light up to the height of a person, or work out if they were stretching their arm up, and illuminate further. "I decided to use the LIDAR-Lite rangefinder, which is a pretty cool but pricey sensor that encodes digital fingerprints into the bursts of laser light it sends out," he tell us. "This means it can uniquely identify the pulses of light that bounce back, so it's not confused by secondary reflections."

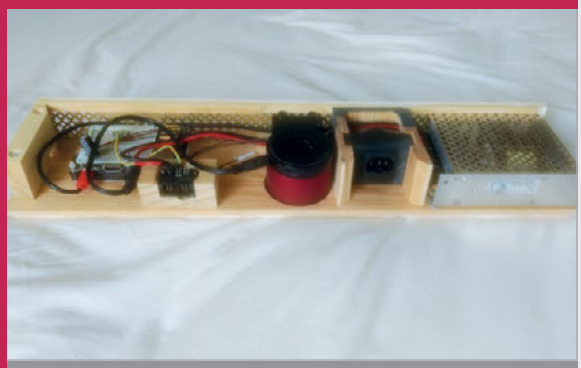
To tie everything together, Roberto created a simple program in Python: "The code polls the laser rangefinder to work out if there is an object closer to the top of the mirror than the mirror base. If there is, it increments the brightness in an array that tracks how bright all the LEDs should be." But it wasn't entirely straightforward. Creating the body of the mirror proved a daunting task.

Learning by doing

"Before I started, I had zero woodwork skills – I'd been terrible at it at school," Roberto admits. He watched several YouTube videos about making mirror frames ("the opposite sides really need to be the same length," he laughs) and he also ended up buying all kinds of powerful tools to get really accurate mitre joints.

Still, it was worth it. During the grand unveiling, accompanied by the sounds of *2001: A Space Odyssey*, he watched the delight on his children's faces. "It had become an almost embarrassing addiction," he says of the process. "But my children love it, and they show it off to their friends when they come round."

LET THERE BE LIGHT



>STEP-01

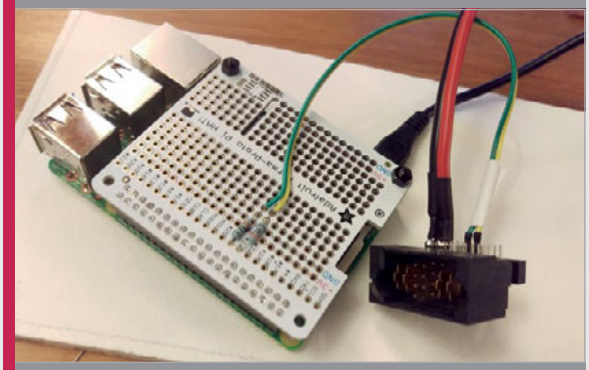
The handy compartment

The electronic components sit inside this removable, easily accessible shelf. It includes a Raspberry Pi, backplane connector, speaker, laser rangefinder, AC power in, and power supply. The decorative brass grille provides ventilation.

>STEP-02

Fixing the lights

The LEDs fit behind the mirror's frame. "Problem is, they have a tiny computer running in each pixel, so extra power taps are needed every metre or so to keep the voltage level high," says Roberto.



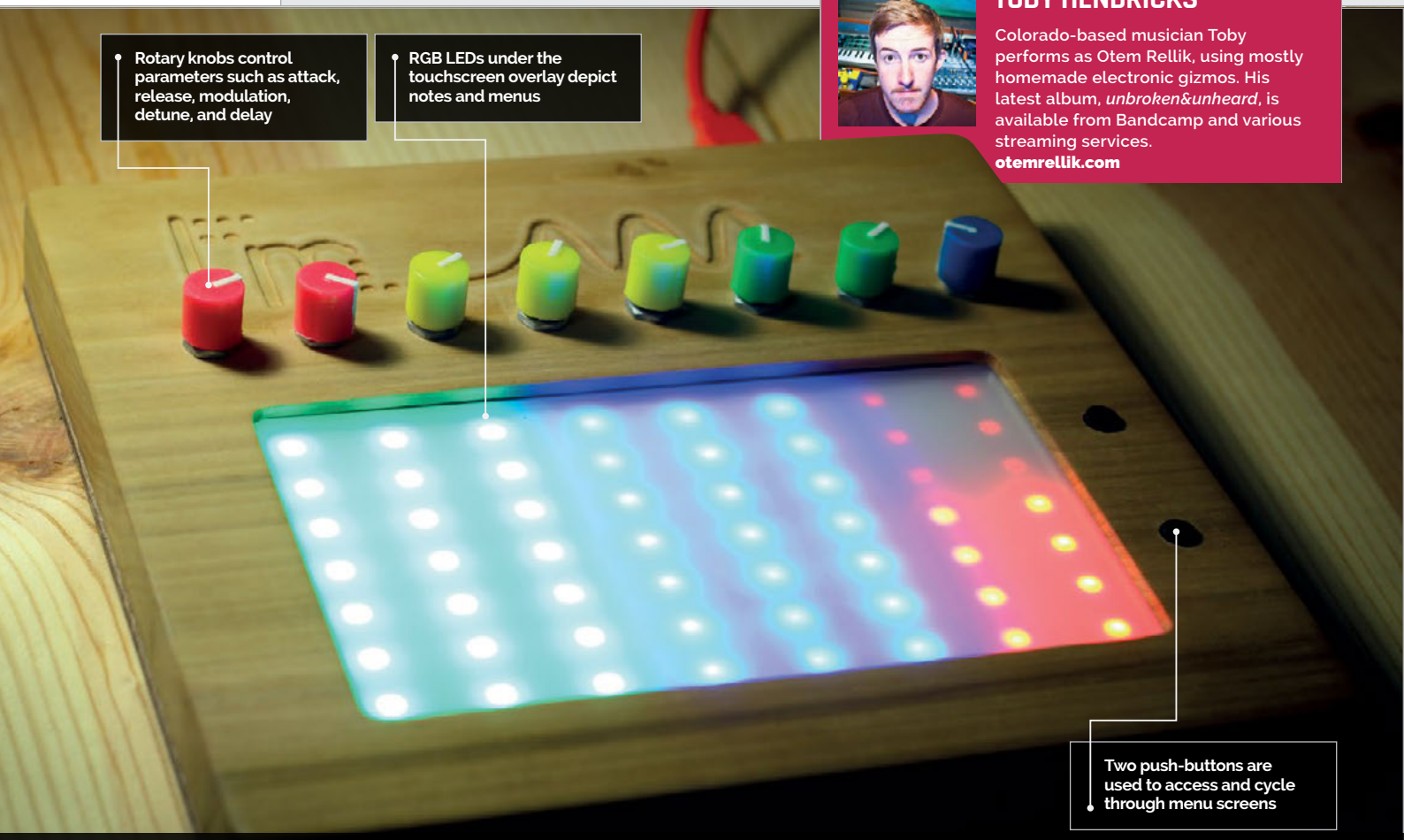
>STEP-03

Connecting everything up

The key I/O components use four-wire connections: I²C for the LIDAR-Lite and SPI for the DotStar. Thankfully, the Pi can handle both. Roberto soldered the connections to an easily attachable Perma-Proto HAT.

TOBY HENDRICKS

Colorado-based musician Toby performs as Otem Rellik, using mostly homemade electronic gizmos. His latest album, *unbroken&unheard*, is available from Bandcamp and various streaming services.
otemrellik.com


Rotary knobs control parameters such as attack, release, modulation, detune, and delay
RGB LEDs under the touchscreen overlay depict notes and menus
Two push-buttons are used to access and cycle through menu screens

FM TOUCH SYNTH

Quick Facts

- It took a month to build and program
- A resistive overlay is used (magpi.cc/2gJSZll)
- Sounds can be stored in eight patch presets
- LEDs are used to display notes and menus
- A Teensy 3.6 handles controls and audio output

Frustrated by unreliable iPad music apps, **Toby Hendricks** built a homemade touchscreen synth based on a Raspberry Pi Zero

Not long after impressing us with his Raspberry Pi Looper 'synth drum thing' (**magpi.cc/2xZTAXR**), Toby Hendricks (also known as Otem Rellik) is back again with another Pi-based musical device. This time he has constructed a touchscreen synthesiser that offers a wide variety of stunning sounds, modified using a combination of rotary knobs and touchscreen control.

"It went through several iterations before I settled on the final design," Toby tells us. "The original idea was to have two touchscreens for two-voice polyphony, but that ended up being a bit too large, so I went with one."

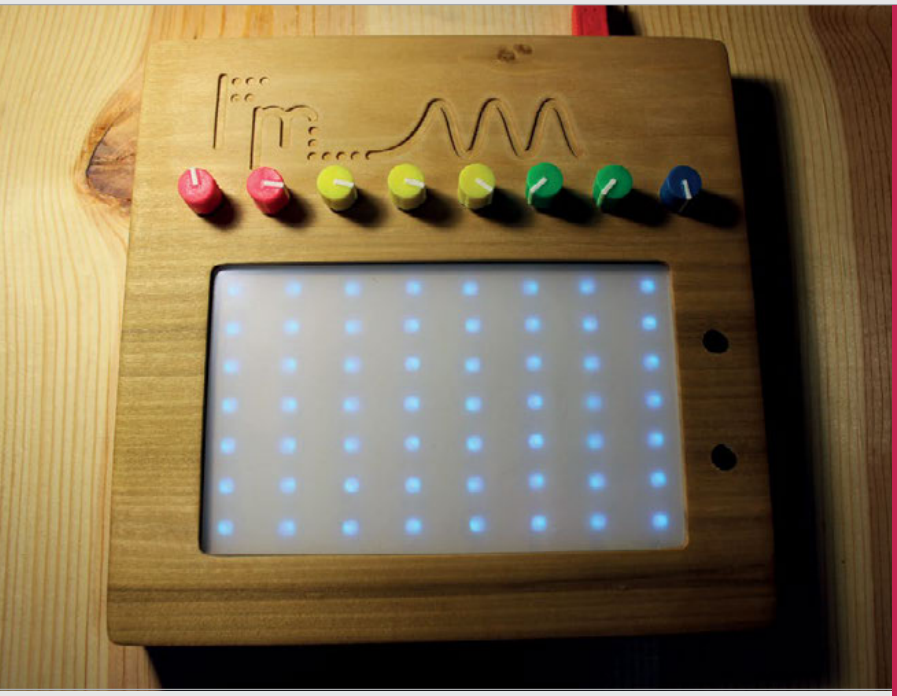
Zero debut

While a Teensy 3.6 board is used to handle the control data, all the audio – created using a combination of FM and subtractive synthesis – is processed in Pure Data on a Pi Zero. "This was my first project using the Zero," says Toby. "I just wanted to see if I could run a somewhat simple Pure Data patch on a Zero without any audio glitches (and it turns out I could). Size was definitely a factor: I wanted to make a really slim, sleek instrument."

Toby says the Pure Data programming language is easy to use. "Once you learn the basics, you can do so much with audio and MIDI. It's a visual programming language, so instead of writing code line by line, you create objects and start connecting patch cables. It's great if you are coming from a non-technical perspective because everything is so easy to understand visually."

Touch the music

While the synth's rotary knobs are used to control aspects such as attack, release, frequency modulation, detune, and delay, the main input interface while playing and creating new sounds is the touchscreen overlay. Columns of RGB LEDs placed beneath it depict eight notes (the scale of A minor), while the position of the player's finger modifies the sound produced.



Rather than displaying information on a regular touchscreen, Toby opted to use LEDs for everything, including menus. "It's a bit more archaic and cryptic. I like to make instruments that you really have to learn to use, and aren't immediately super-accessible. Sort of like the old hand-held video games I grew up with."

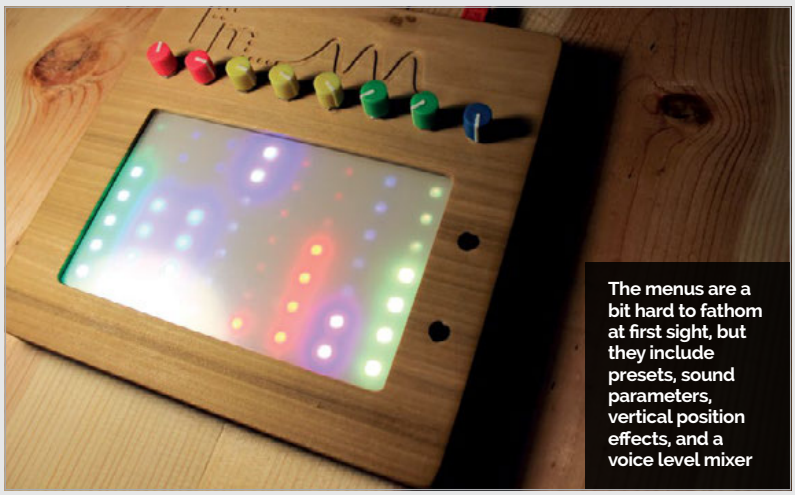
One drawback is that the resistive overlay can only handle one touch at a time, although a workaround involves sustaining notes. "I added the sustain feature close to the end of the project because I wanted polyphony. The synth just sounds so massive when you play it polyphonically. Perhaps in the future I'll upgrade the screen to allow multitouch."

Above Toby is pleased with the case, crafted using his new CNC machine: "I think all my future projects will have wooden cases"

Live project

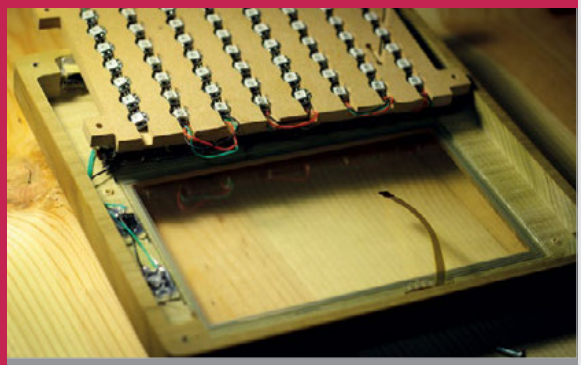
Toby has already used the FM Touch Synth in live performances. "It's working out great! I've been doing a lot of ambient jam sessions with it, turning the delay way up and feeding into my Pi Looper. It's been a lot of fun."

Toby would really like to make the synth available commercially, which is why he hasn't released the code yet, but he's already working on another Pi Zero project: "a looper in which you can manipulate the pitch and speed of the loop in four different slots."



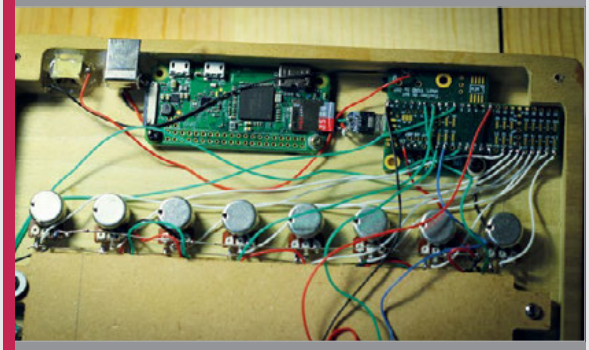
The menus are a bit hard to fathom at first sight, but they include presets, sound parameters, vertical position effects, and a voice level mixer

BUILD A TOUCHSCREEN SYNTH



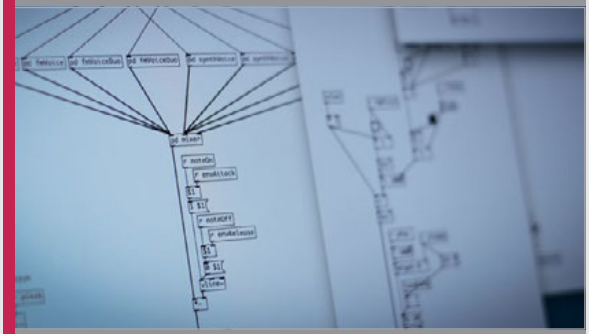
>STEP-01
Making a case

The wooden case was Toby's first project using his new CNC machine. It houses the components, including the matrix of RGB LEDs that sit under the touchscreen overlay.



>STEP-02
Teensy bit of help

Eight rotary knobs and the touchscreen overlay are wired up to a Teensy 3.6, which sends control data to the Pi Zero and also handles audio output.



>STEP-03
Pure Data programming

All the synthesiser sounds are processed on the Pi Zero using Pure Data, a visual programming language in which objects can be created and linked together.

EDIT IMAGES ON YOUR RASPBERRY PI

In spite of its size, the Raspberry Pi makes a powerful image-editing machine

You'll Need

- Raspberry Pi
- Raspbian
- Mirage

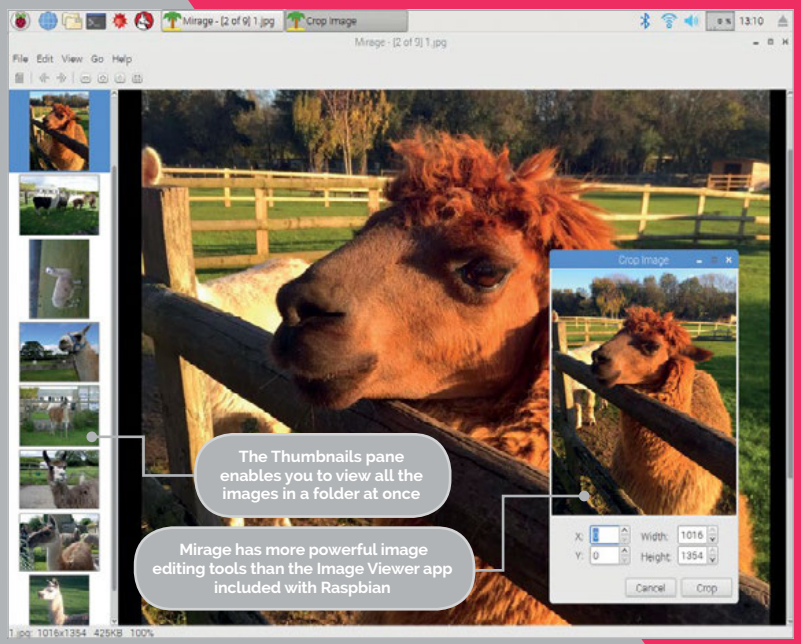
When it comes to image editing on the Raspberry Pi, you have several options. The default program, called **Image Viewer**, is based on **GPicView**. It's extremely fast and lightweight, and you can use it to rotate images.

At the other end of the scale is **GIMP**. Raspbian is built on top of Debian, and most Linux users reach for GIMP (GNU Image Manipulation Program) for heavy image editing. It's capable of professional image retouching, including perspective distortion and channel mixing.

The good news is that GIMP runs just fine on a Raspberry Pi. It could be accused of being overkill for quick image manipulation, but if you want to go the whole hog, enter:

```
sudo apt-get install gimp
```

Then head over to the GIMP Tutorials page to find out what you can do (**gimp.org/tutorials**).


The Thumbnails pane enables you to view all the images in a folder at once
Mirage has more powerful image editing tools than the Image Viewer app included with Raspbian

MIRAGE

In our tutorial, we're going to use something a little lighter, and a little cooler.

We're going to install a program called **Mirage**. This is a lightweight photo viewer that can also resize, crop, rotate, and flip images. It features basic colour editing and file management, and it's perfect for our lightweight needs:

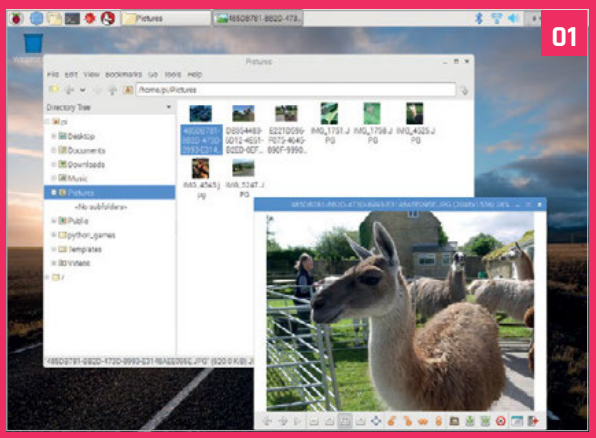
```
sudo apt-get update
sudo apt-get install mirage
```

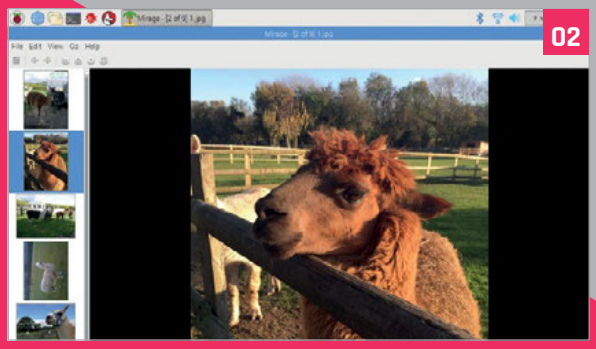
HOW TO: EDIT IMAGES IN RASPBIAN

>STEP-01

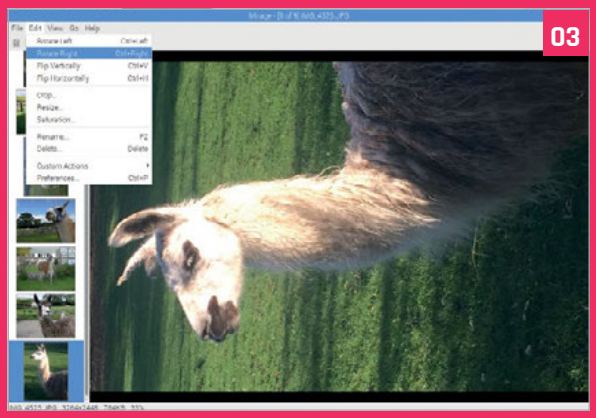
Open in Image Viewer

If all you want to do is view a file, then double-click on it in File Manager (or use **xdg-open** and the file name in Terminal). The Image Viewer app will open, enabling you to view the image. You can use the yellow Rotate and Flip buttons to flip the image around.



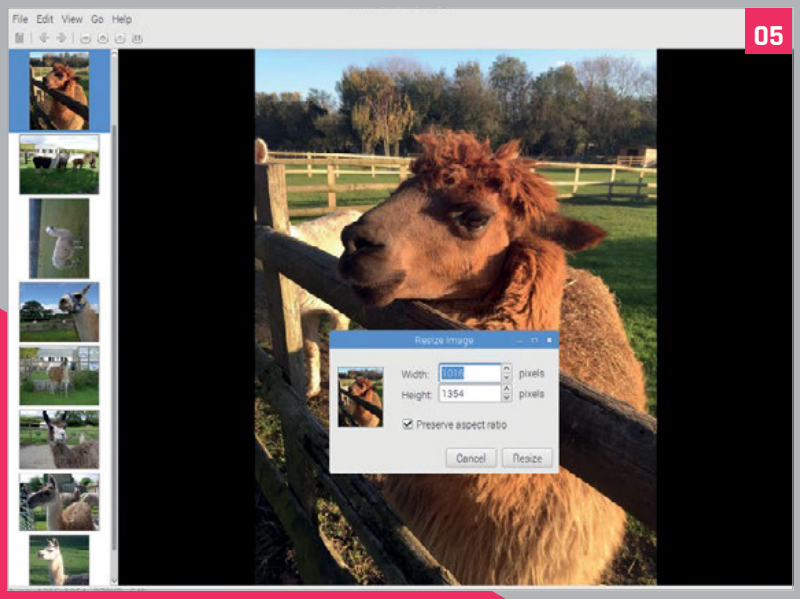


>STEP-02
Open Mirage
For slightly more power in your image editing, open Mirage (Menu > Graphics > Mirage). Now, choose File > Open Image and pick an image on your Raspberry Pi. The Thumbnails Pane on the left shows all the other images in the same folder, which makes it easy to switch between images.

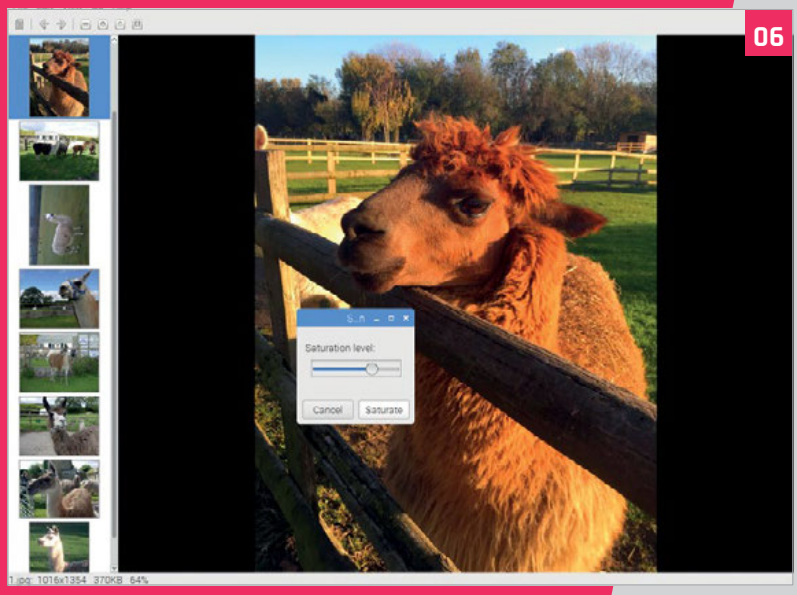


>STEP-03
Rotate images
It's easy to rotate images. Select the image in the Thumbnails page and choose Edit > Rotate Left/Rotate Right. Use Flip Vertically and Flip Horizontally to mirror-flip the image.

>STEP-04
Crop an image
Choose Edit > Crop to open the Crop Image window. You can draw a marquee selection box around the smaller image in the preview window. Its dimensions will display in the X, Y, Width, and Height text boxes (these values can be changed manually). Press Crop to remove the unwanted part of the image.



>STEP-05
Resize an image
Sometimes you need an image set to a specific size, for use on a webpage or to display accurately in a document. Choose Edit > Resize to open the Resize Image window. Adjust the properties in the Width or Height boxes to adjust the image size. By default the image will maintain its proportions; deselect the 'Preserve aspect ratio' box to adjust the Width and Height independently.



>STEP-06
Saturate
While Mirage doesn't have the powerful colour-correction facilities of GIMP, you can adjust the colour saturation (which is often the best tool for touching up an image). Choose Edit > Saturation and use the Saturation level slider to change the value. As you move the slider, the image will display the new levels. Press Saturate when you're happy with the image. Use File > Save Image to keep your edits.

USE PDFS ON RASPBIAN

PDF is a great format for sending and sharing documents, but you can do an awful lot more with a PDF file if you know how

You'll Need

- Raspberry Pi
- Internet connection

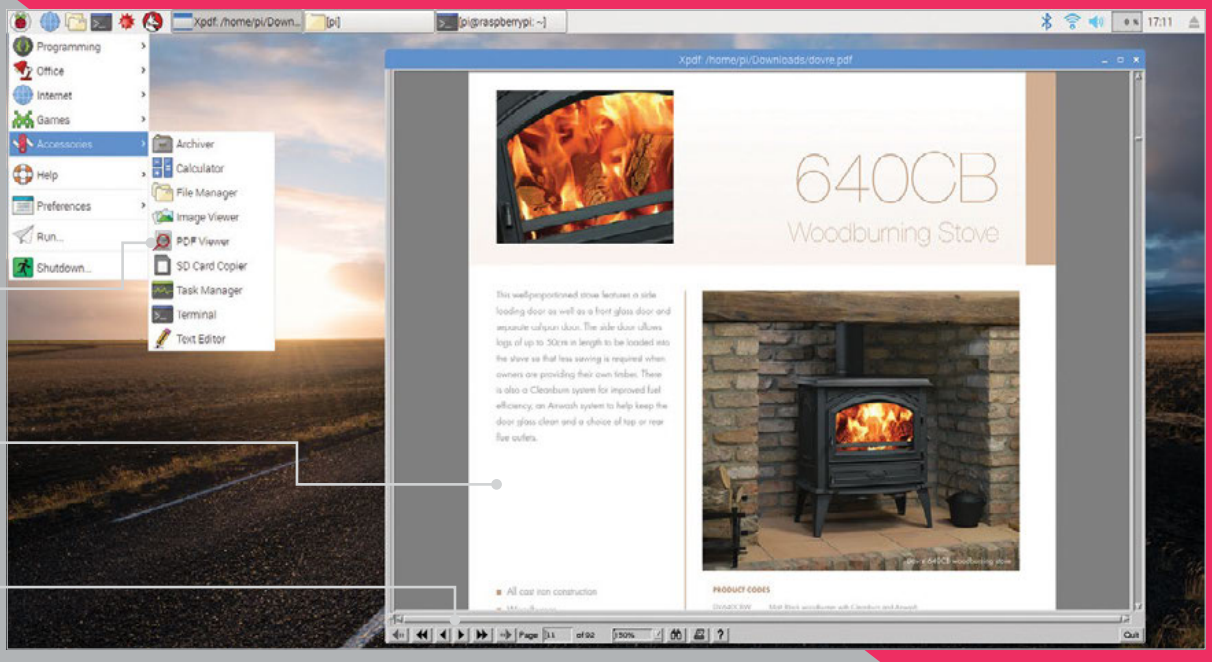
PDF documents have all kinds of uses, from receipts and invoices from online shops, to newsletters and magazines – including this one. Whether you're reading this article in print or as an electronic document, the pages you are reading began as PDF files, which are either sent to a printer or uploaded to the web.

There's a reason for this. PDFs are excellent at preserving complex layouts of text and graphics, meaning that the recipient sees exactly what you intended them to see, regardless of the device and software used.

As well as guaranteeing quality and consistency when distributing documents, the PDF is an excellent tool for archiving documents and information. Rather than printing a receipt from a website or a document you've created, save it as a PDF (often called 'printing to file'). This lets you keep a record that doesn't take up any space, and which you can find easily without rifling through a filing cabinet or a stack of paper.

While we often think of PDF as a read-only file type – something that we can only look at – modern PDF software allows us to edit almost any PDF. For example, if a school emails a PDF letter asking for contact details, you can type those details into the PDF, save it, and email the completed form back. No more printing forms and hoping your child remembers to hand them to the teacher.

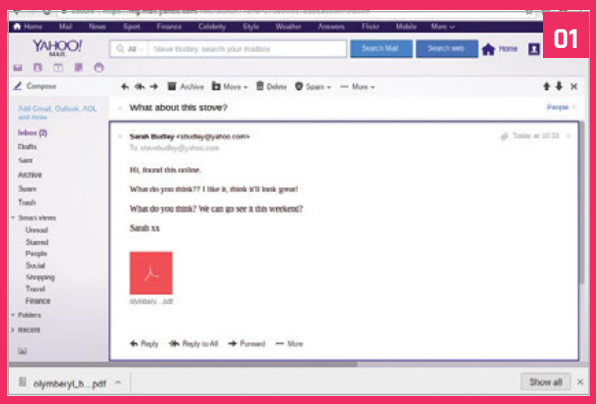
The good news is that you can complete all these tasks using a Raspberry Pi. This includes using the PDF viewer built into Raspbian to open, save, and print documents – but we'll also show you how to install a more advanced PDF viewer to edit your PDF files.



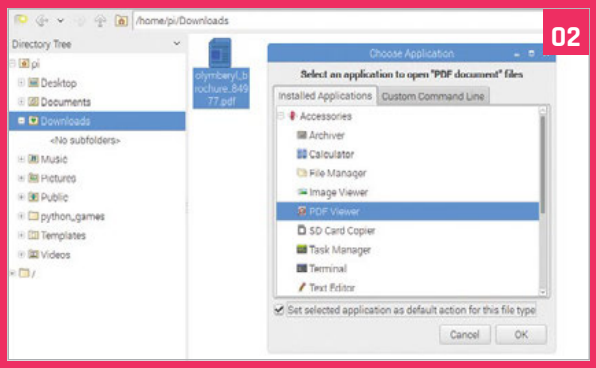
Raspbian comes with a PDF viewer, so you can use PDFs immediately

The PDF viewer (XPDF) is basic, but it can open a complex PDF perfectly

Use these tools to search or print the PDF, and to make it more readable


01
What about this stove?
Hi, found this online.
What do you think?? I like it, think it'll look great!
What do you think? We can go see it this weekend?
Sarah xx

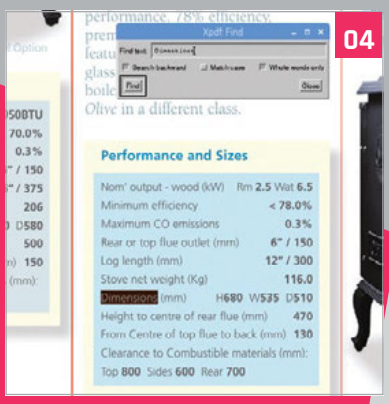
>STEP-01
Saving PDFs
Whether you're viewing a PDF from an email, a download, or a USB drive, save it to your Pi as you would any other file.



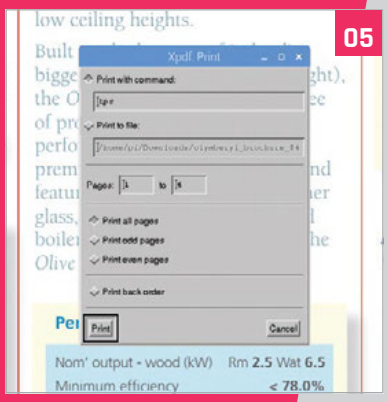
>STEP-02
Opening a PDF
Double-click on a PDF file and you will be asked which application you would like to use to open it. Open Accessories to select PDF Viewer, and tick the box at the bottom to set PDF Viewer as your default PDF program.

>STEP-03
Adjusting the view
To resize your PDF to fit the window, open the zoom menu (click the downwards arrow next to the size box at the bottom of the window). Choose a size, or use 'fit width' if you want the PDF page to be the same width as the window.

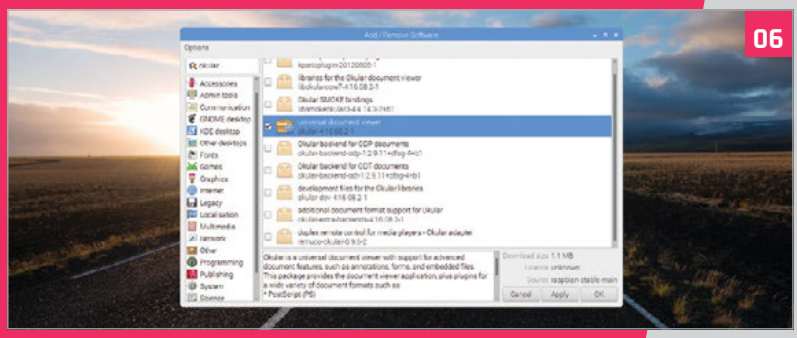
>STEP-04
Searching a PDF
You can search a PDF for specific words by clicking the binoculars button at the bottom of the window. Use 'Match case' or 'Whole words only' to narrow your search.


04
Xpdf Find
Find
Performance and Sizes
Nom' output - wood (kW) Rm 2.5 Wat 6.5
Minimum efficiency < 78.0%
Maximum CO emissions 0.3%
Rear or top flue outlet (mm) 6" / 150
Log length (mm) 12" / 300
Stove net weight (Kg) 116.0
Dimensions (mm) H680 W535 D510
Height to centre of rear flue (mm) 470
From Centre of top flue to back (mm) 130
Clearance to Combustible materials (mm):
Top 800 Sides 600 Rear 700

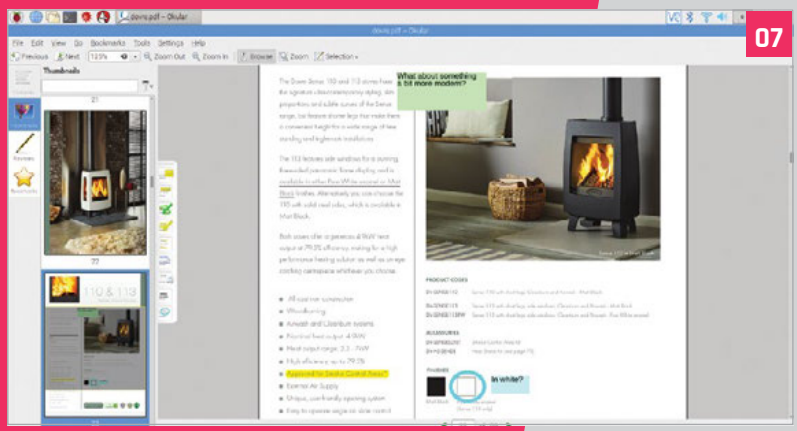
>STEP-05
Printing a PDF
To print your PDF, click the printer button at the bottom of the window. You can print the whole document, or a range using the Pages boxes.



>STEP-06
Installing Okular
If you want to edit a PDF, you'll need to install Okular. Go to Menu > Preferences > Add/Remove Programs. Search for Okular, tick the box, and click OK. To open a PDF in Okular, right-click on the file and select Okular.



>STEP-07
Editing a PDF
Open the Tools menu in Okular and click Review to show the editing tools sidebar. To highlight or underline text, select the text with the cursor (as in a word processor), and click the relevant tool button. You can also add notes and shapes to the document.



MIKE'S PI BAKERY

MIKE COOK

Veteran magazine author from the old days and writer of the Body Build series. Co-author of *Raspberry Pi for Dummies*, *Raspberry Pi Projects*, and *Raspberry Pi Projects for Dummies*.

magpi.cc/259aT3X

THE LARGE HEAD 'N RON COLLIDER

Make a spooky reaction game for your Halloween party

You'll Need

- 12 × mini skull string lights
- 12 × mini pumpkin string lights
- One red/green common cathode LED
- Foot-operated switch and jack socket
- GPIO connector
- Resistors and wire
- Strip pine and MDF sheet
- M3 nuts and bolts

It is time for our annual Halloween project, and publishing this at the end of September gives you plenty of time to get it working for your Halloween party. This time, it's a game with Head the Skull and Ron the Pumpkin, in a race to detect the spooky particles that are emitted when they collide at speed. Just like many of the world's colliders, it works by sending Head one way round a ring of accelerators, and Ron in the opposite direction. All you have to do is to press the foot switch at the instant they pass each

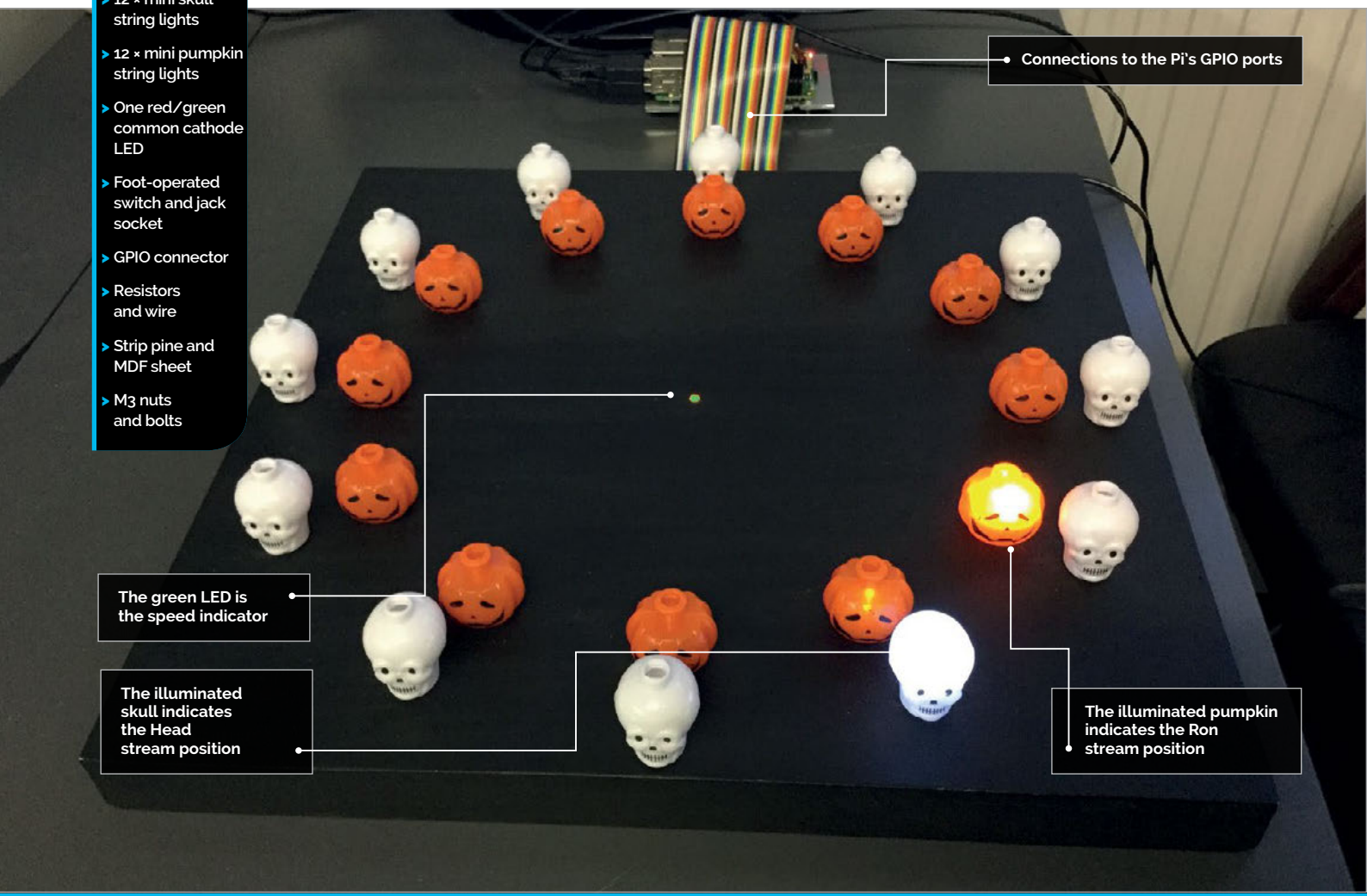

Connections to the Pi's GPIO ports
The green LED is the speed indicator
The illuminated skull indicates the Head stream position
The illuminated pumpkin indicates the Ron stream position

Figure 1 The two strings of LEDs we used for this project

other, once they have accelerated up to full speed. You know when they are up to speed because a speed-monitoring LED at the centre of the collider changes from red to green.

The circuit

We used two very cheap sets of string lights, obtained from our local pound shop, as shown in **Figure 1**. Surprisingly, they each cost a pound. The LEDs are wired in parallel, and utilise the internal resistance of the batteries to keep the LED current in check. In this project, we are going to control them from the GPIO ports of the Raspberry Pi, and provide a real resistor in series with each LED. This project uses all but one of the GPIO pins on the connector, including the I²C HAT identification pins. The LEDs themselves are rather interesting, as they are designed with a 360-degree viewing angle. They use a cone-shaped indent which acts as a reflecting surface, spreading the light all round, as shown in **Figure 2**.

The schematic for our game is shown in **Figure 3** (overleaf), and is pretty straightforward, using LEDs and a switch. The common cathode tri-colour LED is simply a red and a green LED in one package. As there is no data sheet for the string light LEDs, we had to experiment to find out which resistor values produced which levels of current. The forward voltage of the LEDs is close to the 3V3 of the GPIO pins, so we only need low-value resistors to run the white and orange LEDs at 5 mA and 4 mA respectively.

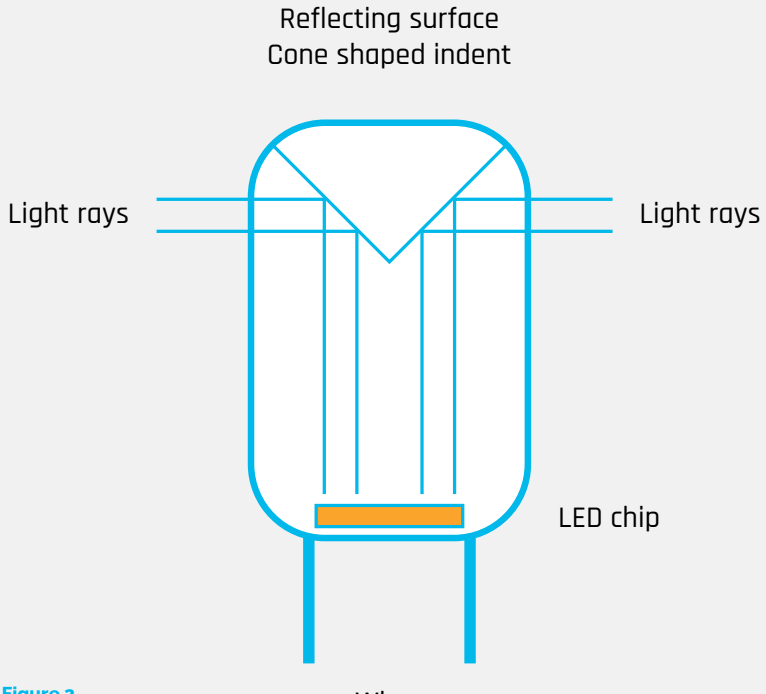


Figure 2
A 360-degree LED

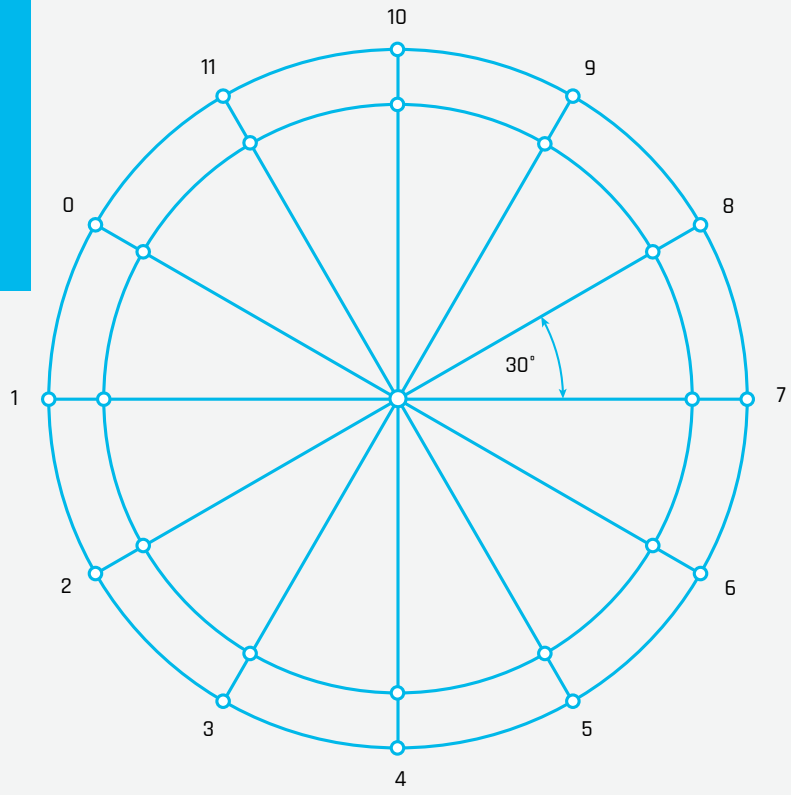
At a cursory glance, you might think that we are overloading the current capability of the GPIO pins (51 mA in total), but the project will only illuminate one LED at a time for the Head and Ron groups, plus one of the two speed LEDs. We could have opted for full buffering and driven the LEDs at 5 V, along with a much higher current, but in the end we chose the

MAKING THE LARGE HEAD 'N RON COLLIDER

>STEP-01
Making the board

Take a piece of 6 mm thick MDF, 330×330 mm in size. Drill a hole in the centre and mark two circles of 150 mm and 120 mm radius, centred on the same point. We made a strip of Perspex with three holes, and used a screw in the centre and a pencil in each hole to draw the circles. Then we then used a 30-degree set square and a ruler to mark the position of the mounting holes, and drilled them with a 3 mm drill bit. Next, we glued on 20 mm stripboard to make a tray, painted it all with a flat black paint, and filed a slot on the right-hand side for the foot switch cable. Finally, we filed a slot on the back edge, near position 10, for the 40-way ribbon cable.

Outer ring - Head's positions 150 mm radius



Inner ring - Ron's positions 120 mm radius

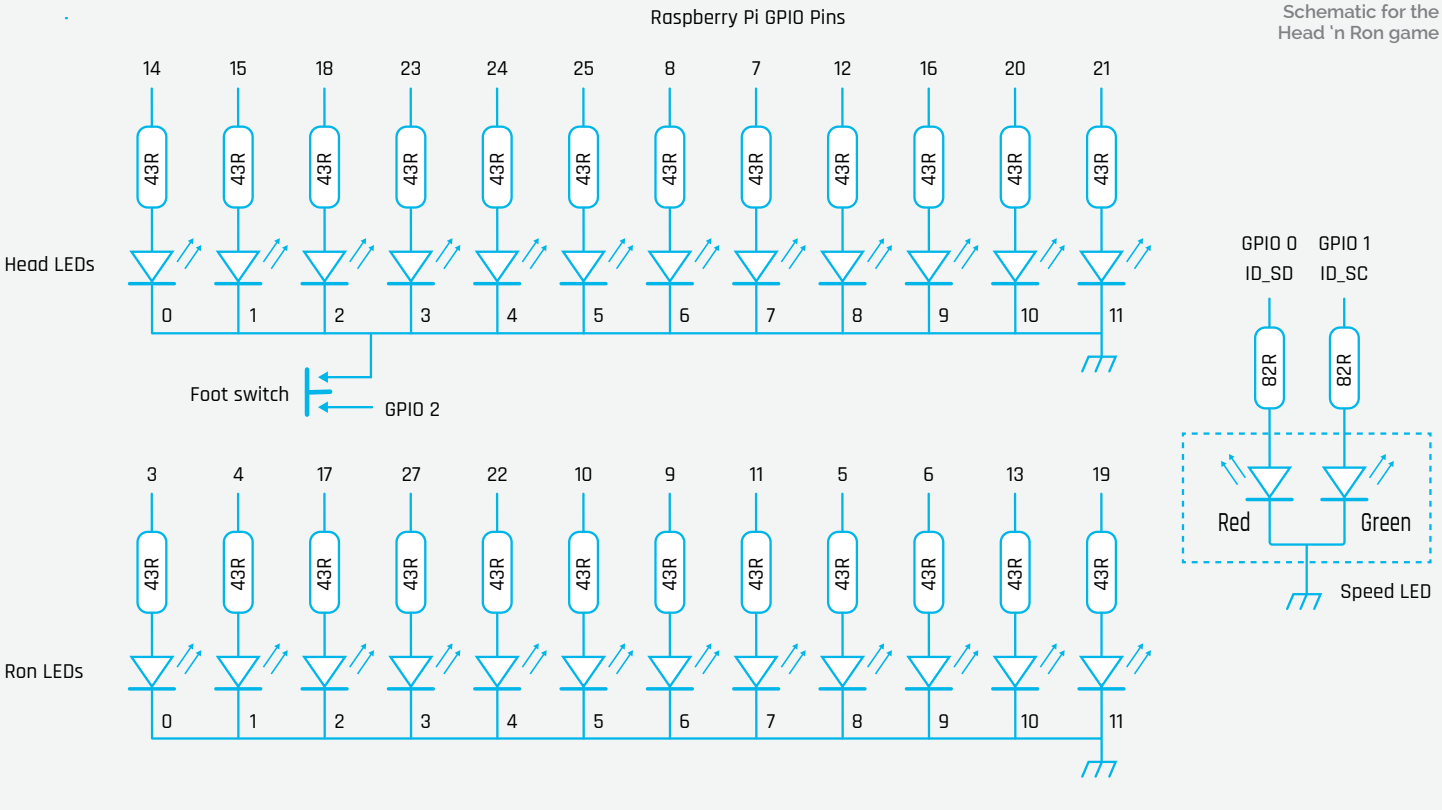
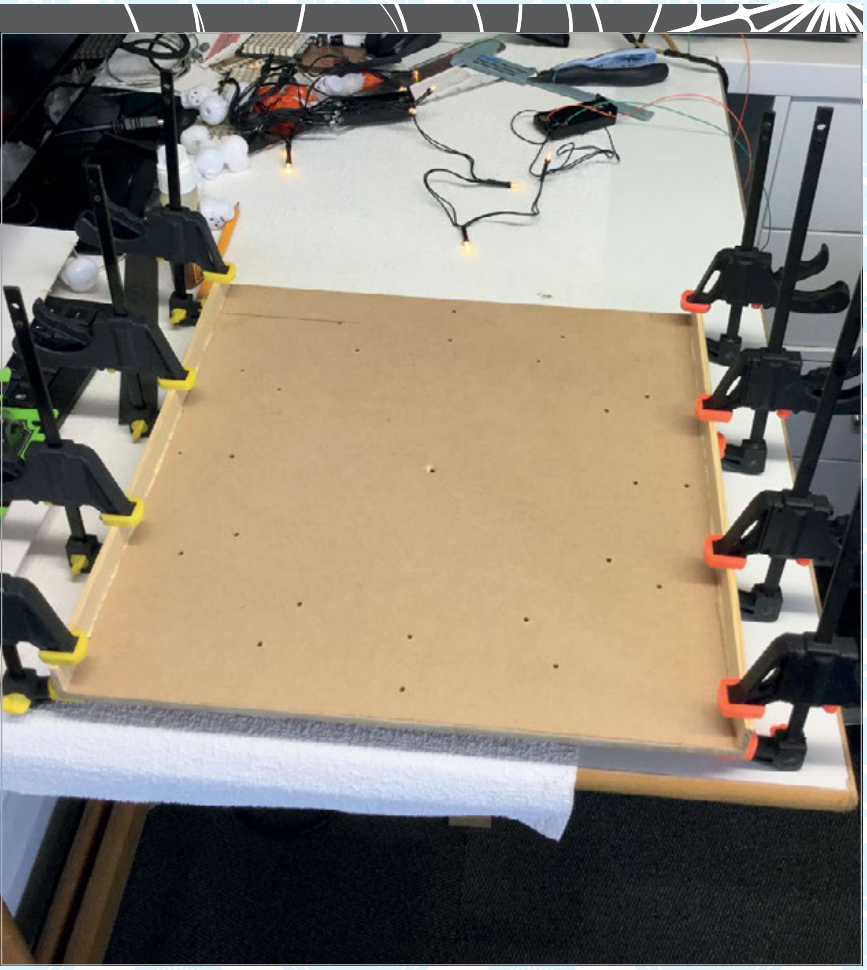


Figure 3 Schematic for the Head 'n Ron game



>STEP-02
Prepare the LEDs

Separate the LEDs by starting at the end of the string and snipping off the two wires, close to the next LED. Repeat this until all the LEDs have two long and two very short wires coming from them. Identify the anode and cathode by applying a voltage (3 to 5 V) through a 470R resistor. The cathode will be the one at the negative terminal when the LED lights up. Identify the cathode with a blob of correcting fluid, or by making the wire 5 mm shorter than the anode. Finally, trim off the shrink insulation from the sides to reveal the two short stubs of wire. Cut these as short as you can so that they are covered by the insulation. This should leave two longer wires.

Figure 4 Hit your foot switch now!

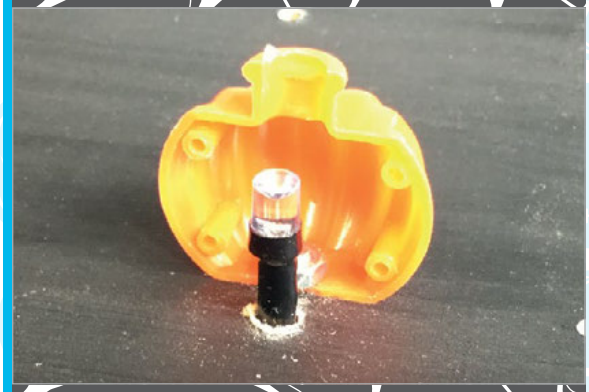
simplest and cheapest option. If you want to develop other games with more LEDs, we would recommend using a buffer, such as the ULN2003A.

The construction of the project is shown in the steps, and takes a bit longer than you might think.

The game

The game takes its inspiration from other forms of large colliders. The two streams go round in opposite directions. When they meet, they are diverted into the same path, and they collide. You have a foot switch to press when the two streams are at the same point.

Watch out – with 12 positions per circle, and moving at the same speed, there may never be a time when the two streams are at the same point. The trick is to make them move at different rates. What's more, it takes time for the streams to accelerate to a colliding speed, and this is signalled when the central LED turns from red to green. If you press the foot switch at the right time, as shown in **Figure 4**, the screech of fundamental spooky particles is released, and the collider starts again – only this time it goes faster! Once you miss, the round ends, and you'll be given a score based on the number of correct hits.

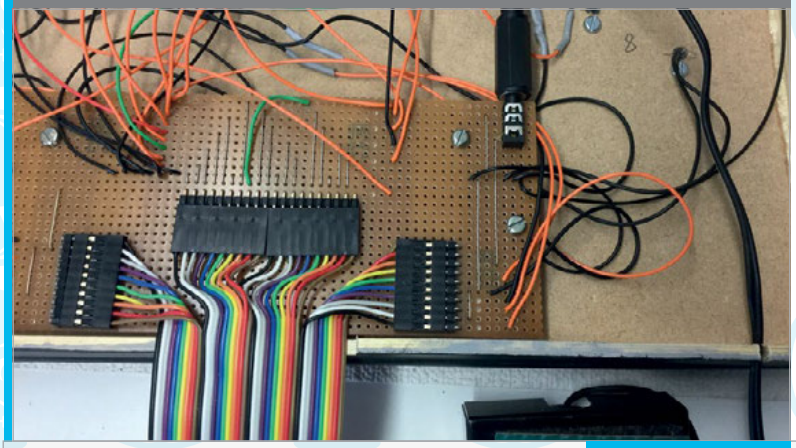


>STEP-03
Mounting the LED shells

Separate the two halves of the plastic skull and pumpkin LED covers. Drill a 3 mm hole in the base of the back half of each cover, and attach each one to the top of the box using a 10 mm M3 screw and nut. For positions 9 and 11, use a 10 mm threaded pillar instead of a nut, as these will act as a mounting for the stripboard. Drill a 5 mm hole in front of each half shell, as close to it as you can, and insert an LED of the appropriate colour. Fix the LEDs in place with hot-melt glue from the underside of the board. Finally, cut holes in the bases of the remaining front-half covers to fit around the LEDs, and clip the front and back of each cover back together.

>STEP-04
Wiring it up

Mark the positions (Head 1–12 and Ron 1–12) on the underside with a pencil so you can identify the LEDs. Wire the GPIO connectors to the appropriate LEDs through the appropriate resistors. We used surface-mount resistors on the back of the stripboard, mainly because we had them in stock at the right value – there is no advantage to using surface-mount resistors over through-hole resistors here. Don't forget to add the jack for the foot pedal as well – it doesn't matter which way around you attach it to GPIO 2. Use the threaded pillars to attach the stripboard to the underside of the game, and the ribbon cable to attach the game to the Raspberry Pi. Do not underestimate the length of time it will take to complete this step – it took us over four hours, including using heat-shrink sleeving to extend the LED wires.



Software

The software uses the Pygame framework to produce the sound. Make a directory called **Sounds** in the same directory as the program, and copy into it the files **Screech.wav** and **Spiral.wav** from the directory **/usr/share/scratch/Media/Sounds/Electronic**. Most of the action is controlled by the **playRound** function, which contains a state machine that decides which (if any) of the streams to move, based on the elapsed time clock. It returns a **true** or **false** signal to indicate whether or not the round is over. The variables **rInterval** and **hInterval** control the speed of each stream, and the variable **speedThreshold** determines when they reach a speed suitable for collision. Altering the **speedInc** variable controls how quickly the streams accelerate up to speed.

Taking it further

You can adjust the variable controlling the final speed of the game, but at its fastest it is quite tricky. The initial slow start ensures that everyone can manage at least one hit. You could add extra sound effects, such a clunky whine as the accelerator ramps up, or a spooky cackle if you miss.

head_n_ron.py

```
001. import pygame,time, random
002. import RPi.GPIO as io
003.
004. pygame.init()
005. pygame.mixer.quit()
006. pygame.mixer.init(frequency=22050,
     size=-16, channels=2, buffer=512)
007. random.seed()
008.
009. def main():
010.   global score, rightSpeed, speedThreshold, hInterval,
     rInterval
011.   global countR, countH
012.   print("Head n Ron collider game")
013.   print("Ctrl C to quit")
014.   init()
015.   while 1:
016.     clr()
017.     countR = random.randint(0,11)
018.     countH = random.randint(0,11)
019.     score = 0
020.     hInterval = 2.0 ; rInterval = 1.5
021.     speedThreshold = 1.0
022.     io.output(speed[0],1)
```

Language
>PYTHON

DOWNLOAD:
magpi.cc/1NqJjmV

PROJECT VIDEOS

Check out Mike's Bakery videos at:
magpi.cc/1NqJnTz

```
    io.output(speed[1],0)
    rightSpeed = False
    while playRound(): # keep going until you miss
      pass
    miss.play()
    print("Score",score)
    a = input("Press return to play again")

def playRound():
  global countH, countR, lastRon, lastHead, overlap,
score
  global rightSpeed, rInterval, hInterval,
speedThreshold
  done = False
  if time.time() - lastRon > rInterval:
    countR = moveR(countR)
    lastRon = time.time()
    if countR == countH:
      if io.input(2) ==1 :
        overlap = True

    if not rightSpeed and rInterval > speedInc:
      rInterval -= speedInc
      hInterval -= speedInc
      if rInterval < speedThreshold:
        io.output(speed[0],0)
        io.output(speed[1],1)
        rightSpeed = True
  if time.time() - lastHead > hInterval:
    countH = moveH(countH)
    lastHead = time.time()
    if countR == countH:
      if io.input(2) ==1 :
        overlap = True

  if countR != countH and overlap: # have they passed
    overlap = False

  if io.input(2) ==0 :
    if overlap and rightSpeed:
      print("bang")
      bang.play()
      while pygame.mixer.get_busy():
        pass
      overlap = False
      # make go faster
      if speedThreshold > speedInc:
        speedThreshold -= 0.1 #change colliding speed
        hInterval = 2.0 ; rInterval = 1.5
        score +=1
        io.output(speed[0],1)
        io.output(speed[1],0)
        rightSpeed = False
        time.sleep(0.8)
    else:
      if not rightSpeed:
        print("not going fast enough")
      else:
        print("not in the right position")
        done = True
  return not done

def moveH(count):
  io.output(heads[count],0)
  count += 1
  if count > 11:
    count = 0
  io.output(heads[count],1)
  return count

def moveR(count):
  io.output(rons[count],0)
  count -= 1
  if count < 0:
    count = 11
  io.output(rons[count],1)
  return count

def init():
  global heads, rons, speed, hInterval, rInterval
  global countH, countR, lastRon, lastHead, overlap
  global rightSpeed, speedInc, speedThreshold, bang,
miss
  countH = 4 ; countR = 0
  lastRon = time.time()
  lastHead = time.time()
  overlap = False ; rightSpeed = False
  heads = [14,15,18,23,24,25,8,7,12,16,20,21]
  rons = [3,4,17,27,22,10,9,11,5,6,13,19]
  speed = [0,1] #speed LED
  hInterval = 2.0 ; rInterval = 1.5
  speedInc = 0.1
  speedThreshold = 1.0
  io.setwarnings(False)
  io.setmode(io.BCM)
  io.setup(heads, io.OUT)
  io.setup(rons, io.OUT)
  io.setup(speed, io.OUT)
  io.setup(2, io.IN) # foot switch
  bang = pygame.mixer.Sound("sounds/Screech.wav")
  miss = pygame.mixer.Sound("sounds/Spiral.wav")

def clr():
  for led in range(0,12):
    io.output(heads[led],0)
    io.output(rons[led],0)
  io.output(speed[0],0)
  io.output(speed[1],0)

# Main program logic:
if __name__ == '__main__':
  try:
    main()
  finally:
    clr()
    pygame.mixer.quit()
    pygame.quit() # close pygame
```

K.G. ORPHANIDES

K.G. has been writing about technology and sound for two decades, and can be heard on podcasts with subjects ranging from gaming to political philosophy.
twitter.com/KGOrphanides

MAKE A PODCAST MACHINE

Your Raspberry Pi is a perfect pocket-sized PC for podcasting – we'll show you how to record, edit and publish your own online radio programme

You'll Need

- A microphone
- Speakers or headphones
- Audacity
- Google account
- Internet connection

Although it's a little short on memory when it comes to heavy-duty multi-track audio editing, a passively cooled Pi runs completely silently, which makes it easy to create clean voice recordings with minimal background noise.

These instructions will work perfectly on any Debian-based Linux distro, such as Raspbian or Ubuntu MATE. As you're going to be recording raw PCM audio, we recommend using a reasonably large microSD card if you plan to keep previous recordings for posterity.

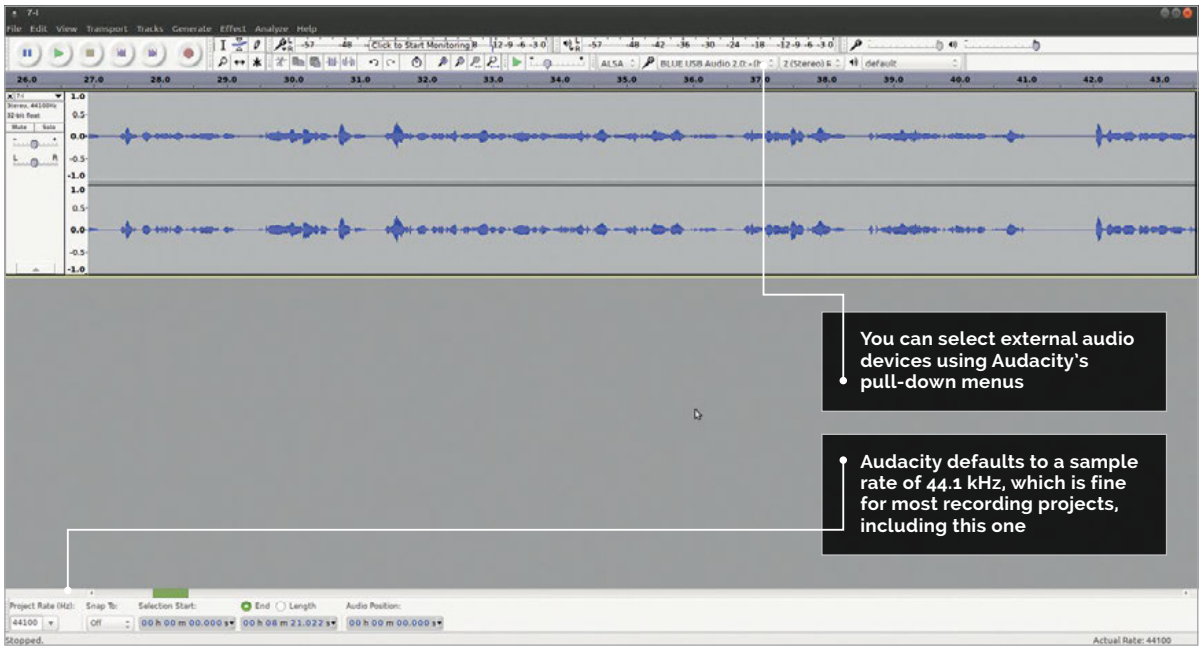
Although we'll be exporting the audio files at a lower quality, we recommend recording at a minimum sample rate of 44.1 kHz. This is Audacity's default setting, so you won't need to change anything.

>STEP-01

Get connected

Connect your speakers and microphone to your Pi. You can get away with using your TV's built-in speakers via an HDMI connection, but connecting headphones to the 3.5 mm analogue port makes for a more private editing experience.

A USB gaming headset with a built-in microphone will do in a pinch, but we recommend a USB condenser mic for better quality voice recording. We're fans


You can select external audio devices using Audacity's pull-down menus
Audacity defaults to a sample rate of 44.1 kHz, which is fine for most recording projects, including this one

OPTIMISE ANALOGUE AUDIO QUALITY

The Pi's headphone port can add unwanted background noise. To minimise this, set your mixer volume to 100 percent and use a good-quality power supply.

of the Blue Microphones Yeti, but you can get good budget options such as the Blue Snowball iCE and Samson Go Mic for less than £50.

>STEP-02

Record your podcast

Install Audacity by opening a Terminal window and typing **`sudo apt-install audacity`**. Open the program, and make sure it is using the correct audio input and output devices by checking the device pull-downs on the taskbar, or by opening Preferences from the Edit menu.

Before you start recording, we recommend writing a script or prompts to work from. If you stumble, just pause, go back a few sentences and start again – you can cut out the error later. For easier editing and processing later, it is often more convenient to break longer recordings into 10- or 15-minute chunks.

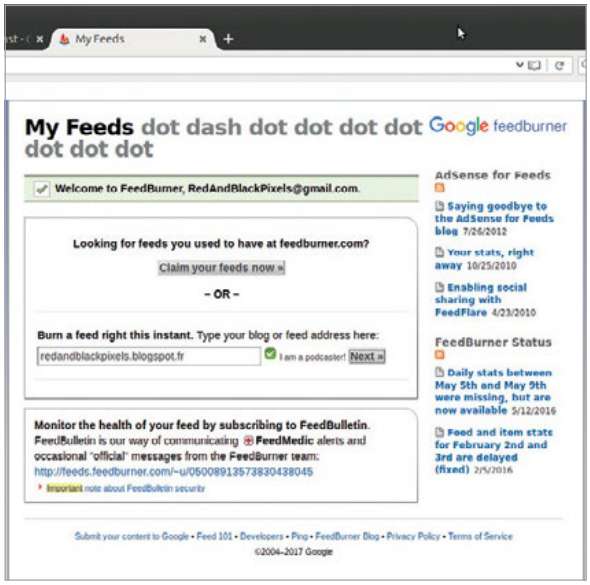
>STEP-03

Edit and process

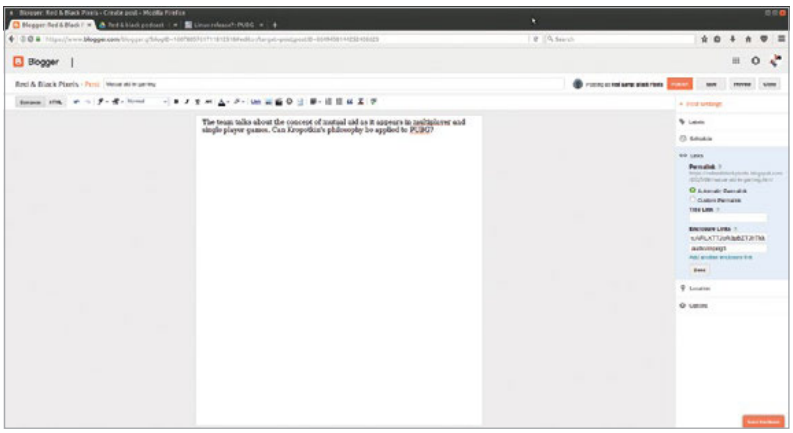
Once you've finished recording, it's time to edit out any errors and use a few effects to improve the recording's quality.

To reduce background noise such as computer or fan hum, highlight a few seconds of audio with only background noise. Select Noise Reduction from the Effect menu and select Get Noise Profile. Then select your entire track, open Noise Reduction again, and hit OK.

To balance and amplify your recording if it's too quiet, select the entire track and apply the Normalize effect using its default settings. Finally, go to File > Export Audio, and encode your recordings as MP3s – we recommend 96kbps joint stereo for voice.


My Feeds
My Feeds dot dash dot dot dot dot Google feedburner dot dot dot
Welcome to FeedBurner, RedAndBlackPixels@gmail.com.
Looking for feeds you used to have at feedburner.com?
Claim your feeds now »
- OR -
Burn a feed right this instant. Type your blog or feed address here:
redandblackpixels.blogspot.fr
I am a podcaster!
Next »
Monitor the health of your feed by subscribing to FeedBulletin.
FeedBulletin is our way of communicating FeedMedic alerts and occasional "official" messages from the FeedBurner team:
http://feeds.feedburner.com/~u/0500891357383043804 5
Important note about FeedBulletin security
AdSense for Feeds
Saying goodbye to the AdSense for Feeds blog 7/26/2012
Your stats, right away 10/25/2010
Enabling social sharing with FeedFlare 4/23/2010
FeedBurner Status
Daily stats between May 5th and May 9th were missing, but are now available 5/12/2016
Feed and item stats for February 2nd and 3rd are delayed (fixed) 2/5/2016
Submit your content to Google • Feed 101 • Developers • Ping • FeedBurner Blog • Privacy Policy • Terms of Service
©2004–2017 Google

Above Feedburner turns your blog into a podcast feed that will work with popular directories such as iTunes and Stitcher



Above Use Blogger's Enclosure Links field to post your MP3 files once you've uploaded them to Google Drive

>STEP-04

Create your blog

Go to **drive.google.com** and log in to the Google account you want to use. If you don't already have a Google account, you can sign up for one on this page.

Go to **blogger.com** and sign in using your Google account. Create a Blogger or Google+ account. When the main Blogger interface loads, hit the Create New Blog button. Pick a name, custom blogspot URL, and theme.

To allow MP3 embedding, go to Settings > Other and switch the Enable Title Links and Enclosure Links settings to Yes. Now select Save Settings at the top right-hand corner of the screen.

>STEP-05

Upload your podcast

In Google Drive, create an appropriately named folder. Set the folder's privacy to allow 'anyone with the link' to view the files in it. Upload your first MP3, right-click on it and select Get Shareable Link. Copy the link.

Return to Blogger and hit the New Post button. Give your podcast an appropriate title and description, using the Title field and Post Body respectively. In the Post Settings box on the right, select Links. Paste your MP3's URL into the Enclosure Links field and give it a MIME type of audio/mpeg3. Hit Publish, and we're ready to go live.

>STEP-06

Launch your media empire

Go to **feedburner.com** and sign in with your Google account. Paste your blog's main URL (**yourcustomurl.blogspot.co.uk**) into the Burn A Feed box, tick 'I am a podcaster', and click Next.

Select the feed you want to use – we prefer the longer-established RSS option, but Atom works too. Feedburner will ask you to confirm the title and the address you want to use.

Your podcast is ready for subscribers, but you should click Next to fill in extra information for the iTunes podcast directory. Feedburner tells you what you need, including an image and a more detailed description, and can even provide listener stats.

GET LISTED

For extra exposure, list your podcast on online directories. The most important is iTunes, which you can you join at **magpi.cc/2x233hl**

BILL BALLARD

Bill is a retired physicist who got back to his programming roots and found fun things to do with his ten Raspberry Pis, even while sailing.
github.com/wpballa

SIMULATE CIRCUITS WITH XYCE ON PI

Compile Xyce, an open-source state-of-the-art circuit simulator, on a Raspberry Pi

You'll Need

- Latest version of Raspberry Pi Desktop/ Raspbian
- 16GB SD card (or preferably a larger solid-state drive or hard drive)

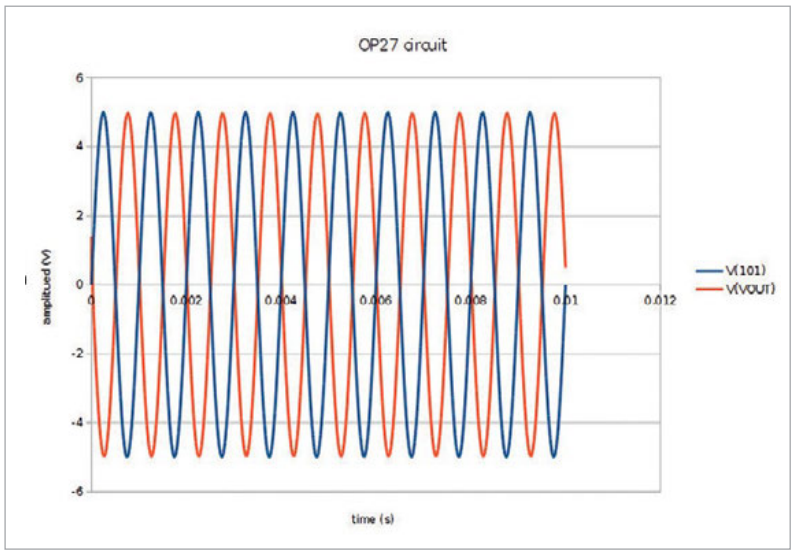
There are many circuit simulators, such as SPICE, TINA or DoCircuits, available for use in designing circuits. However, most of them are either limited-use free versions or academic programs. Xyce is an open-source and fully functional circuit simulator developed by Sandia National Laboratories (supported by the US Department of Energy), that you can compile on a Raspberry Pi.

A quick warning: there are challenges associated with compiling using the limited memory on a Pi, and this project will take about a half day to complete, even on a Raspberry Pi 3.

System preparation

Start by updating and upgrading your distribution. Xyce does not compile on systems with only 1GB of memory. The minimum recommended is 4GB, so next we must expand the swap file size to accommodate the compilation:

```
sudo nano /etc/dphys-swapfile
```



Below Input [V(101)] and output [V(VOUT)] of the operational amplifier inverter circuit. Note transient at start due to poor initial condition assumption

Change the **CONF_SWAPSIZE** from 100 to 2048 (the maximum possible), save, and exit. Next make the change effective:

```
sudo dphys-swapfile setup
```

When you have compiled the code, you can reset the swap file to 100Mb if you like.

Install the required utilities for the compilation:

```
sudo apt-get install gfortran cmake bison
flex libsuitesparse-dev libtool
```

Install Fourier transform libraries

Next, install the Fortran fast Fourier transform libraries. Use the Chrome browser to do all the downloading. Go to **magpi.cc/2vI69FW** and get the 3.3.6 release via tar.gz – this will put the file in your **Downloads** folder. Navigate to the **Downloads** directory in a Terminal window and unzip and extract the file:

```
cd ~/Downloads
tar xzf fftw-3.3.6-pl2.tar.gz
```

Now build and install **fftw**:

```
cd fftw3-3.3.6-pl2
./configure
make
sudo make install
```

Install Trilinos libraries

Next, we install the Trilinos libraries, a very powerful set of serial and parallel solvers. Go to **trilinos.org** and navigate to Download > Previous Releases. In the Pages section on the right-hand side of the screen, find the version 12.6.3 link. You want this version

Left Xyce is an open-source, fully functional circuit simulator

for Xyce 6.7, as later versions aren't guaranteed to work with Xyce. Trilinos is free, but you will need to sign up to access the files. Download and unzip the Trilinos files:

```
cd ~/Downloads
tar -xzf trilinos-12.6.3-Source.tar.gz
```

The last command places the source code in **~/Downloads/trilinos-12.6.3-Source**, but we want to do an 'out of source build', so create a directory to do this:

```
cd ~
mkdir Trilinos12.6
cd Trilinos12.6
```

Xyce only uses some of Trilinos, and there is a suggested reconfigure file on their build page. You can find a modified version at **magpi.cc/2vI6loE**, called **reconfigure**. The SRCDIR line assumes you have followed the instructions above. Make sure that **reconfigure** is executable, run it, and then build the code. The **make** command will take about an hour and a half to complete.

```
chmod u+x reconfigure
./reconfigure
make
sudo make install
```

Build Xyce

Download Xyce from **magpi.cc/2vIj36H**. Register for free, and the downloads page will open. Grab the files containing the source code **Xyce-6.7.tar.gz**, as well as the regression suite **Xyce_Regression-6.7.tar.gz**, and the documentation **Xyce_Docs-6.7.tar.gz**. These will arrive in your **Downloads** directory.

```
cd ~/Downloads
tar xzf Xyce-6.7.tar.gz
cd ~
mkdir Xyce6.7
cd Xyce6.7
```

The next line places the documentation in the proper Xyce folder:

```
tar xzf ~/Downloads/Xyce_Docs-6.7.tar.gz
```

Get the file **config** from the GitHub directory and make sure it is executable. Then compile and install, which will take an hour or so.

```
chmod u+x config
./config
make
sudo make install
```

Next, we test things with the regression suite. Staying in the **Xyce-6.7** directory, unpack and execute the regression suite:

```
tar xzf ~/Downloads/Xyce_Regression-6.7.tar.gz
cd Xyce_Regression-6.7/TestScripts
./run_xyce_regression
```

The regression suite takes a while to execute. A few tests related to calling Xyce as a library will fail, and the huge test problem (RCladder), which uses more memory than the Pi has, will fail, but the vast majority should pass.

A sample problem

A favourite test problem is a detailed model of the OP17 operational amplifier. The net list is available in the Xyce GitHub, as **OP27.cir**. Copy this file to a directory on your Pi, and run Xyce with the command:

```
Xyce -l op27.log -o op27.prn OP27.cir
```

The log file is defined by **-l**, **-o** defines the output file, and the final argument is the input netlist. This will only take a few seconds to execute. You can inspect the **op27.log** file to see how things went. LibreOffice Calc can be used to view .prn files, so use it to open **op27.prn**. Visualise the output by selecting the time and voltages, and creating a graph (x-y line). You can clearly see the inverting nature of this circuit setup.

Start designing!

Xyce will run most standard netlists for SPICE with just a few minor modifications. The **Xyce Reference Guide** in the **Documentation** folder lists the specific changes needed for several popular circuit simulators.

Now you have a state-of-the-art circuit simulator on your Raspberry Pi for your next design project! Note that many manufacturers provide free SPICE models for their components on their websites.

Language
>XYCE

FILE NAME:
OP27.CIR

DOWNLOAD:
magpi.cc/2vI6loE

MOVING XYCE TO ANOTHER PI

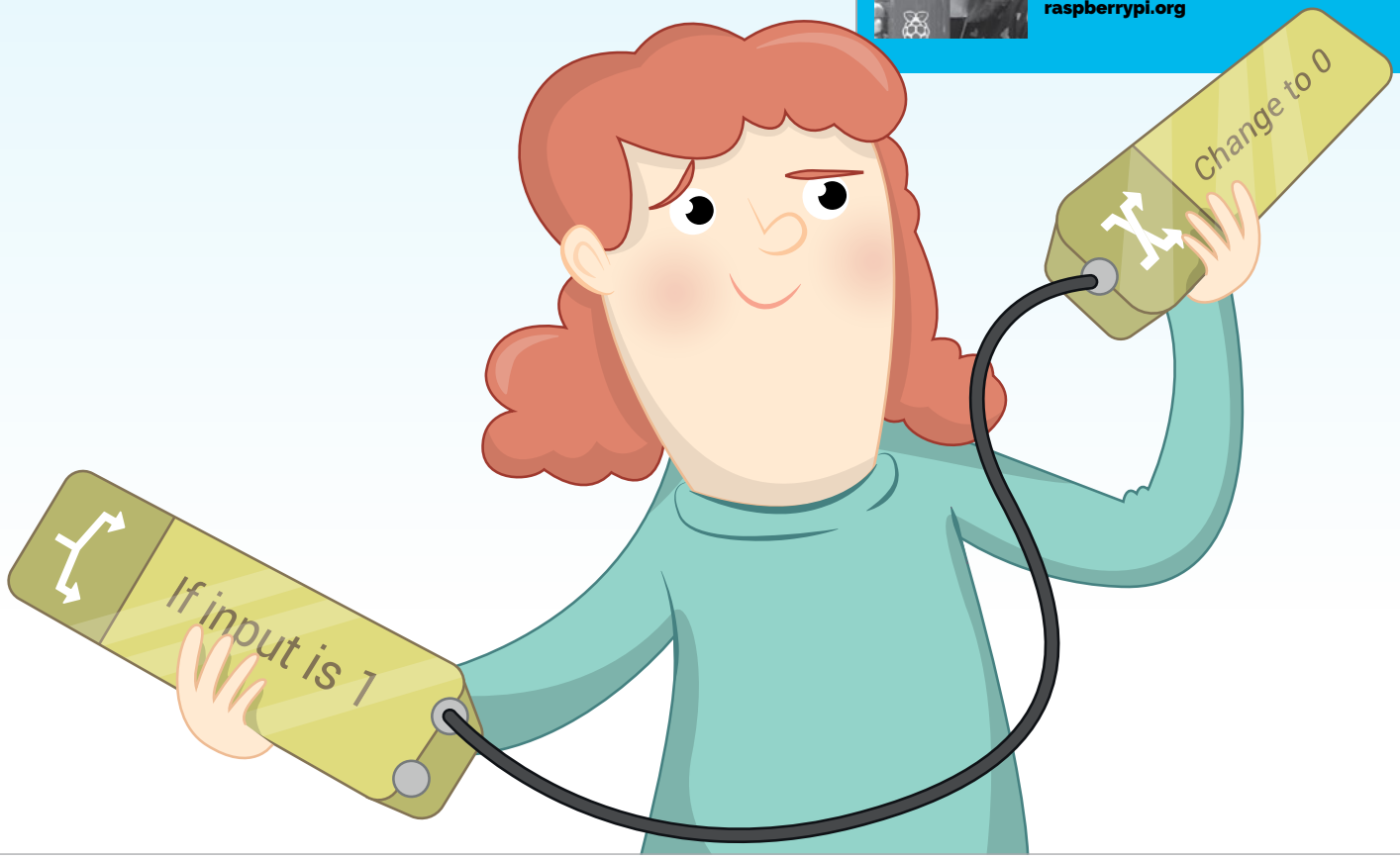
When you have a compiled version, only the libsuitesparse-dev libraries and the compiled code are required on another Raspberry Pi.

EXTERNAL HARD DRIVE

Use an external solid-state or hard drive to speed up the compilation and allow space for project files.

LAURA SACH

Laura is Content and Curriculum Manager at the Raspberry Pi Foundation.
raspberrypi.org



GET STARTED WITH NODE-RED

Learn how to use the visual programming language designed for IoT

You'll Need

- 1 × LED
- 1 × solderless breadboard
- 4 × male-to-female jumper leads
- 1 × 330 Ω resistor
- 1 × tactile push button

In this tutorial, you'll learn how to use Node-RED to communicate with the Raspberry Pi's GPIO pins. Node-RED is a drag-and-drop visual tool which comes pre-installed on Raspbian. Here, we'll create a Node-RED 'flow' to control LEDs.

By doing this, you'll learn how to set up Node-RED flows and use them to control GPIO pins. We'll also cover how to use Node-RED inputs, outputs, and a switch (equivalent to a selection statement); and how to use Node-RED to simulate a NOT gate acting on inputs from a button.

To start, wire up an LED to GPIO 17 on your Raspberry Pi. **Figure 1** shows how to do this.

The positive leg of the LED is usually longer than the negative leg, and it is the positive leg that should be inserted into the left-hand side of the breadboard in this diagram.

Start Node-RED

Start up your Raspberry Pi. Click on the raspberry icon in the top left-hand corner of the desktop screen, then go to Programming > Node-RED. This should launch a window displaying information about Node-RED.

Now open the Chromium web browser. In Chromium, type **localhost:1880** in the address bar, then press **ENTER**. This will display the Node-RED interface.

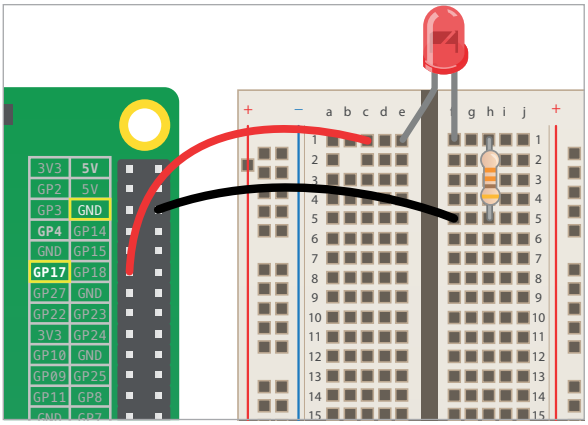


Figure 1 Wire up an LED to GPIO 17 – make sure you use the 330 Ω resistor as shown

Your Raspberry Pi does not need to be connected to the internet to use Node-RED: **localhost** is the address the Raspberry Pi uses to refer to itself and **:1880** means that it is looking at port 1880.

Connecting to a GPIO pin

Programs in Node-RED are called flows. You can see that your blank page is labelled as **Flow 1** in the tab at the top (see **Figure 2**). You can create as many flows as you want, and they can all run at the same time. In this guide, we will create one flow.

The coloured blocks on the left-hand side of the interface are the nodes. Scroll right down to the bottom of the list and you will see some nodes labelled **Raspberry Pi**.

You will see two nodes with the label **rpi gpio**: these are the ones we will use to talk to the GPIO pins on the Raspberry Pi. The first one in the list, with the raspberry icon on the left, is for inputs. Using a button-push to control something would be an example of an input. The second node, with the raspberry icon on the right, is for outputs. Switching on an LED would be an example of an output. Drag an output node onto the blank page in the middle of the screen.

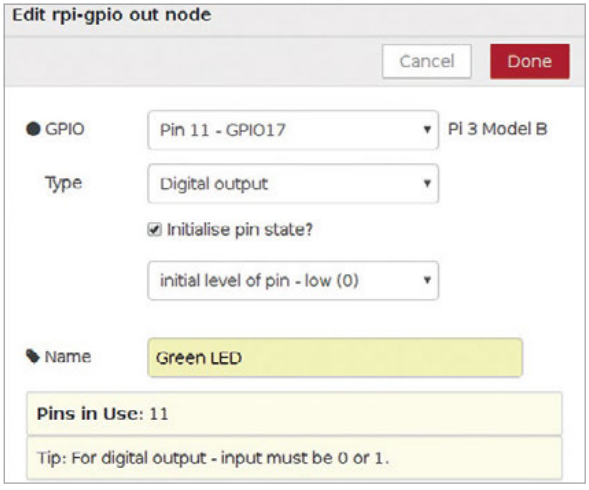


Figure 3 Setting up a node for your flow

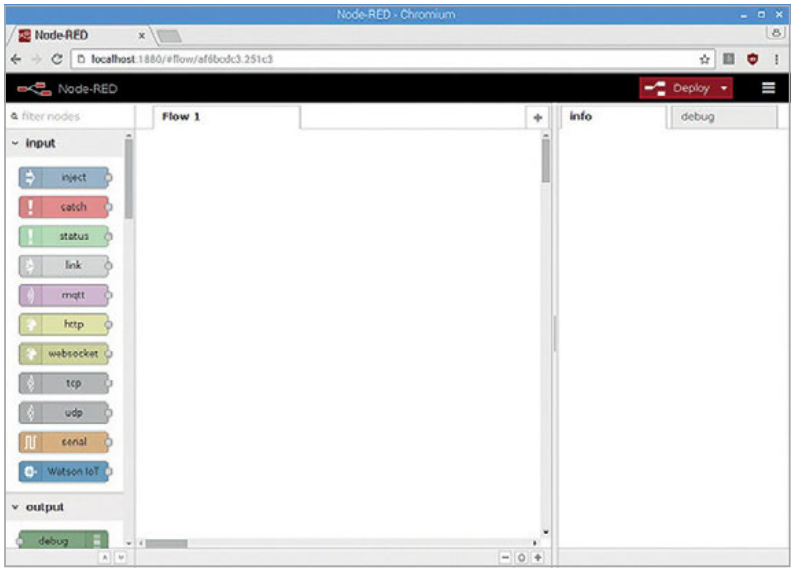


Figure 2 The default Node-RED window as it appears in the browser

Double-click on the node, and a configuration box will appear (see **Figure 3**). Change the GPIO pin to GPIO 17 and make sure 'Initialise pin state?' is ticked. Leave the setting for 'Initial level of pin' on low. Give the node a name – we called it Green LED because the LED we used was green, but if yours is a different colour, feel free to change the name. When you have finished, click Done.

Injecting messages

Now scroll back up to the list of nodes. To turn the LED on and off, we need an input. In Node-RED, we can inject messages into the flow and cause things to happen as a result. Drag an Inject node onto the flow.

Double-click on the Inject node. Use the drop-down menu next to Payload to change the data type to **string**, and type **1** in the Payload box – this will be the message. Type **On** in the Name box. Click Done.

Repeat the previous steps to create another Inject node, but this time add **0** as the payload message, and call this node **Off**.

Now look for the grey dot on the right-hand side of the Inject nodes. Click and drag from the grey dot on the On node to the grey dot on your LED node to join them up. Repeat for the Off node, also joining it to the LED node. **Figure 4** shows how this should look.

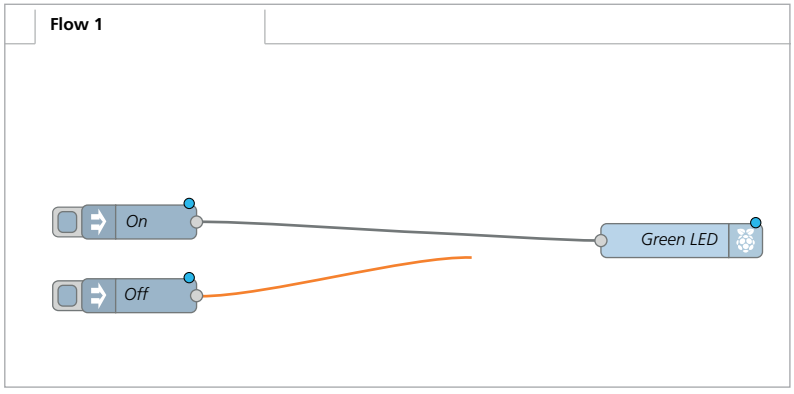
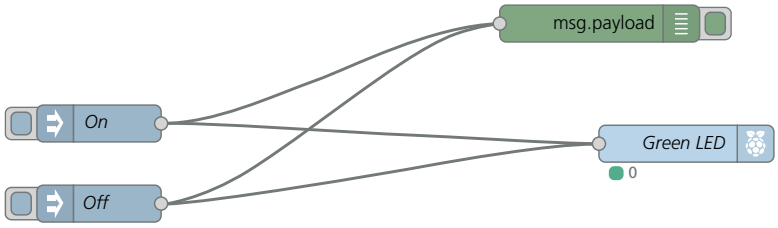


Figure 4 Putting the flow together



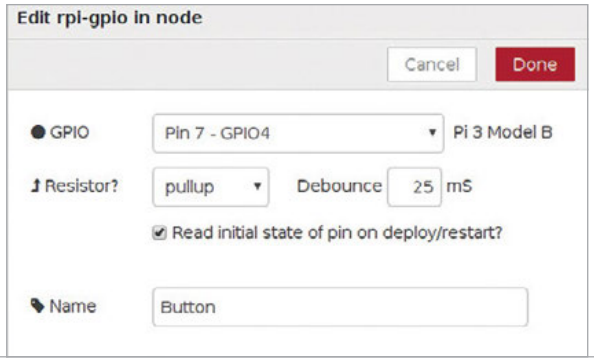


Figure 5 The debug tool allows you to figure out where your flow might be going wrong

Figure 7 Adding a button input is easy

Deploying the flow

Our flow is finished, so now we can deploy it. Click on the big red Deploy button in the top right-hand corner of the screen. A message should pop up at the top saying 'Successfully deployed'. This is like pressing the green flag in Scratch, or **F5** to run your code in Python.

Now click on the blue square on the left of the On node to inject the message **1**. The Green LED node receives the message, and your LED should light up. You should be able to turn the LED off by clicking the blue square on the Off node, which injects the message **0**.

Debugging your flow

If your LED doesn't turn on and off, check that you have wired the components correctly on the breadboard. Make sure you have wired your LED to both ground and GPIO 17 on your Raspberry Pi.

You can also ask Node-RED to display debugging information by wiring up your nodes to a Debug node, which can be found under Output. Drag in a Debug node, wire your two Inject nodes to it (see **Figure 5**), then click Deploy. When you click the buttons to inject the message, the Debug tab on the right-hand side of the screen will show you what was injected. Click the tab to display the messages.

Adding a button

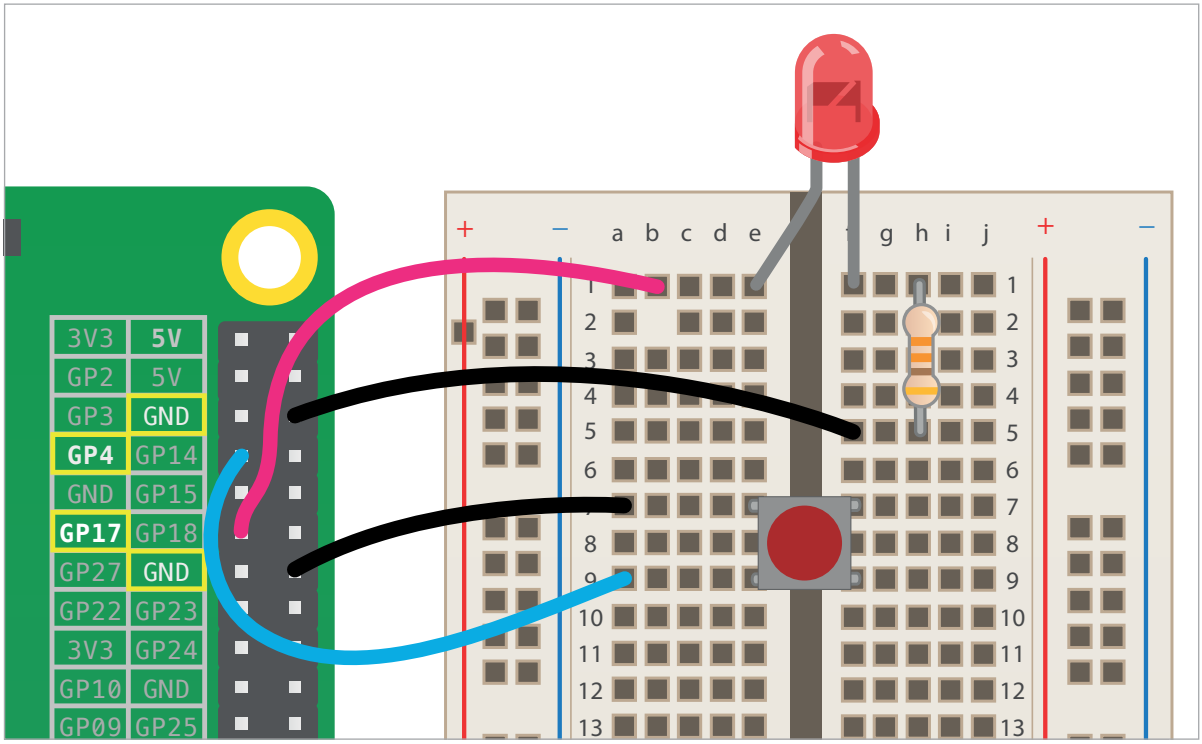
Now let's add a button to control the LED. Wire up your button to the Raspberry Pi as shown in **Figure 6**, so that your LED is still connected to GPIO 17, and your button is connected to GPIO 4.

Remove your Turn on and Turn off Inject nodes by clicking the node and pressing **DELETE** on the keyboard. We no longer need these, as we will be controlling the LED using a physical button.

Now we need to add a Raspberry Pi GPIO Input node. This is the node with the raspberry icon on the left. Set up this node to receive input from your physical button, as shown in **Figure 7**.

Specifying **pullup** means that GPIO 4 will be set to HIGH, and pressing the button will cause it to go to LOW.

Figure 6 Wiring up the button doesn't require much more work



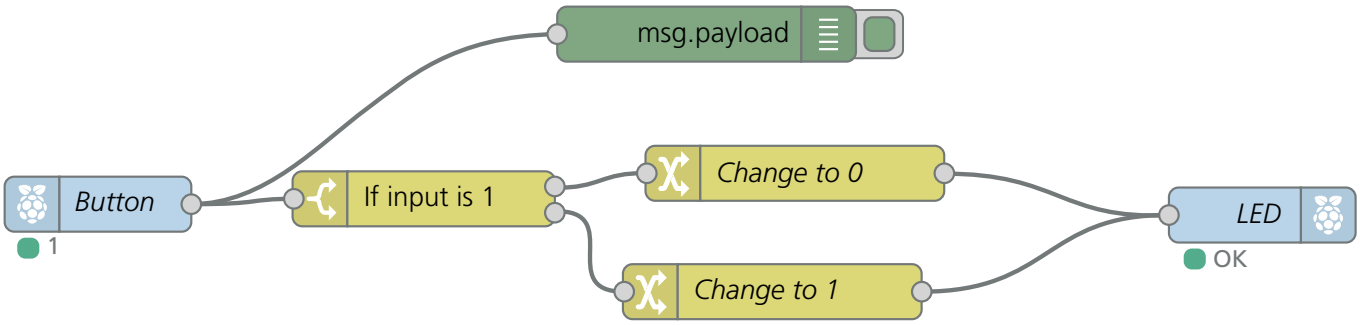


Figure 9 It is very simple to create a working circuit in a Node-RED flow

Now join your Button node output to the existing Debug and LED nodes. Deploy the flow and test it by pressing the button.

You will notice that the LED is lit to start with, and that pressing the button switches it off. That's not quite right! This is because we are using **pullup**, so the button pin will be HIGH by default. HIGH generates the message **1**, and this turns the LED on. When we press the button, we cause the pin to go LOW, generating a **0** message which turns the LED off. We need to reverse the values. We want the LED to receive the message **0** by default, and the message **1** when the button is pressed.

Fixing the button

Remove the connection you made between the Button node and the LED node by clicking on the line and pressing **DELETE** on the keyboard.

Add a Switch node. This can be found in the Function section. This node is similar to the **if/elif/else** constructs you may have seen in Scratch or Python. You can configure it to have multiple output paths (outlined in red in **Figure 8**), depending on the value passed in. In this case, we will set up the node so that if the property **msg.payload** is equal to **1**, the first path will be followed. Click the small Add button at the bottom to add a second path, and for this path select **otherwise** in the drop-down menu. This path will be followed if the input is anything other than **1**. **Figure 8** shows how your screen should look. Click Done when you have finished.

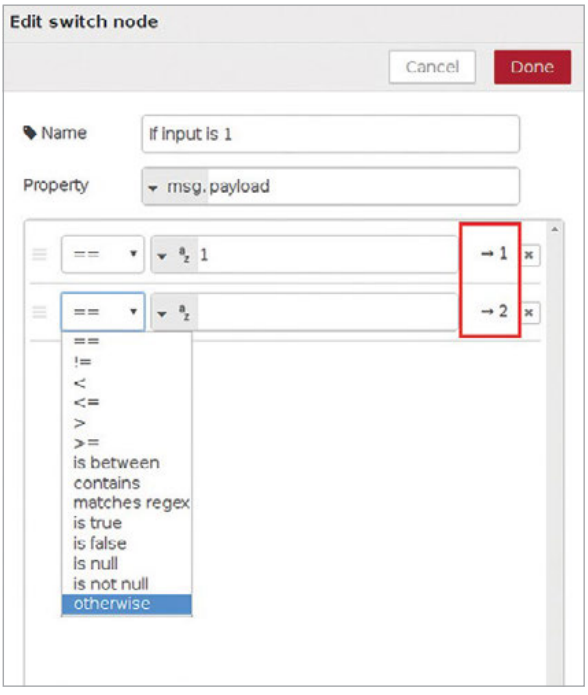


Figure 8 The switch is needed to make sure the button can be used properly

> "Make sure you have wired your LED to both ground and GPIO 17 on your Raspberry Pi"

You should see your newly created Switch node, with two dots on the right-hand side for outputs. Note that the title **If input is 1** is simply a description of what the node does, and has no effect on its function. Join up the GPIO input Button node to the input (left-hand side) of the Switch node.

Now drag in a yellow Change node from the Functions section, and double-click on it to configure it. We will use this node to change the message being sent. Remember: when we created the Switch node, the first output was set to be followed if the input message was **1**. We will use the Change node to change the message to **0**.

Press Done, then draw a line from the first output of the Switch node to the Change node. Then connect the output of the Change node to the LED node. Now add another Change node to set the **msg.payload** to **1**. Connect this node to output 2 of the Switch node, and then to the LED node (see **Figure 9**).

This tells the flow that when the **otherwise** branch is followed (i.e. the **msg.payload** is not already **1**), we would like to change it to **1**. When you are ready, deploy your flow, and then push the physical button to confirm that it works properly.

The hydroponic food garden one month after transplant: 100 pots containing about 450 plants

KENT ELCHUK

A Raspberry Pi enthusiast, web developer, and gardening author who is likely to be tinkering with code or working in the garden.
growlode.com

MONITOR A HYDROPONIC GARDEN

Set up a webcam with moisture sensors and remote access to ensure big yields

You'll Need

- Motion **magpi.cc/2gVrlp2**
- Soil moisture sensor **magpi.cc/2gX3lSN**
- USB webcam
- Raspberry Pi 3

The cost of food is rising. Why not use your Pi to build a hydroponic garden? Eat better and dodge those expensive food prices! Hydroponic growing is efficient, healthy, and easy to maintain – especially when you can build a system that allows you to leave the garden, and monitor it remotely from an internet connection, for under $50 (£38).

Growing pesticide-free, hydroponic, or organic hydroponic produce has never been easier – especially now that the Raspberry Pi is here to help. A hydroponic garden might not be the first place you would expect to find a single-board computer, but in this project it provides essential video monitoring and moisture detection.

The project also uses a Raspbian-compatible plug-and-play webcam to provide the video, and the Motion Linux tool to handle the monitoring. To detect soil moisture, you can pick up a cheap breakout board online. The sensor can be assembled in minutes, with just a few connections that hook up to three Raspberry Pi GPIO pins and a moisture-detecting probe.

Moisture detection and video monitoring will provide the information you need to take care of your hydroponic garden, and you can be alerted to any problems via your internet connection. A simple home web server is all you need.

Visual monitoring

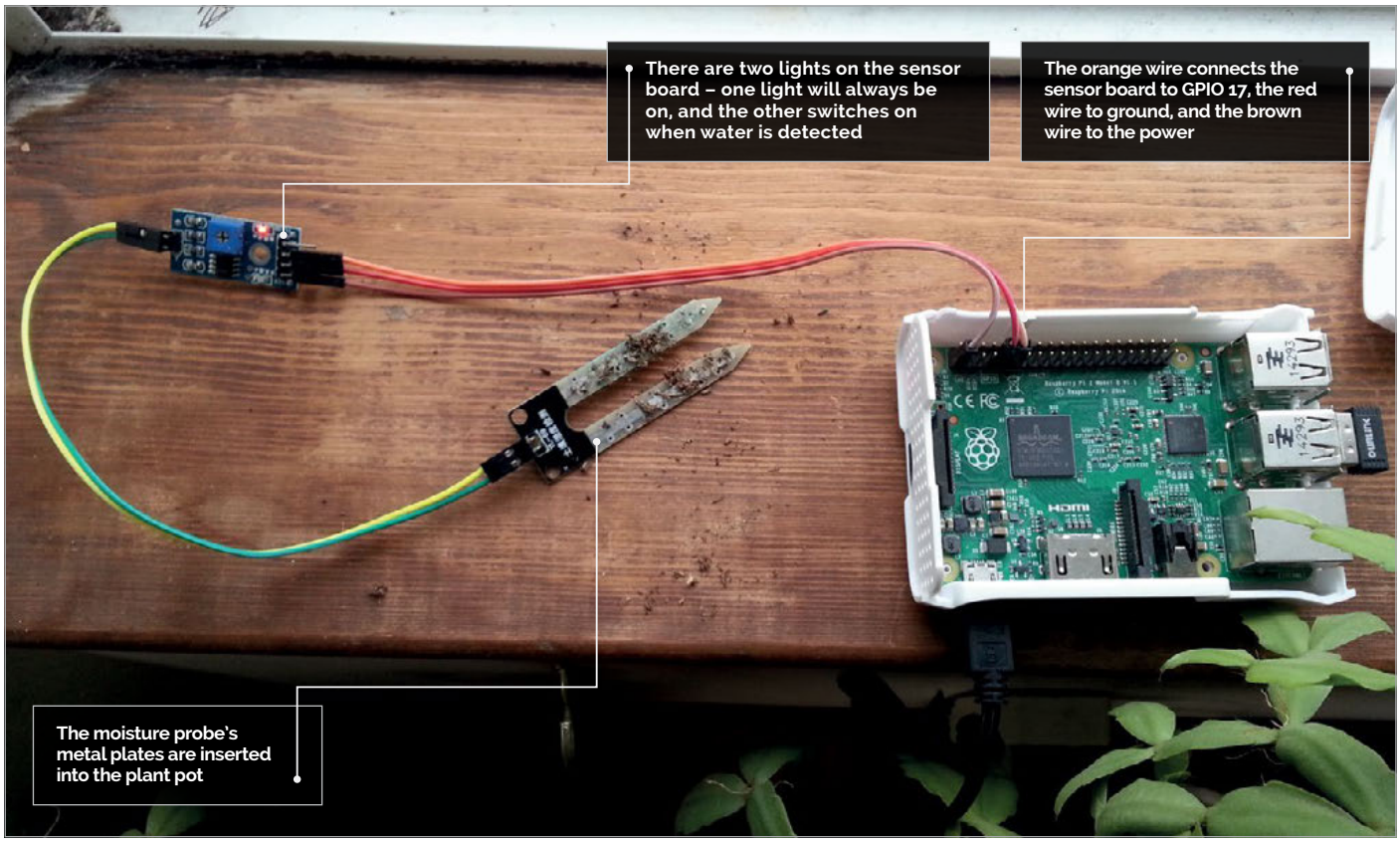
Nothing can replace visual monitoring of your garden. Using your webcam, you can inspect your crop from remote locations. First, you'll need to install Motion:

```
sudo apt install motion
```

The next step is to edit the **/etc/motion/motion.conf** file. You will need to edit it in a text editor such as vim or nano:

```
nano /etc/motion/motion.conf
```

Carefully make changes to the file to match the following code. Until you make these changes, the


There are two lights on the sensor board – one light will always be on, and the other switches on when water is detected
The orange wire connects the sensor board to GPIO 17, the red wire to ground, and the brown wire to the power
The moisture probe's metal plates are inserted into the plant pot

system won't work. It is a good idea to back up the original file before making any changes.

```
  daemon on

  width 640

  # Image height (pixels). Valid range:
Camera dependent, default: 288
  height 480
  framerate 5
  ffmpeg_output_movies on
  snapshot_interval 60

  stream_localhost off
  webcontrol_localhost off
```

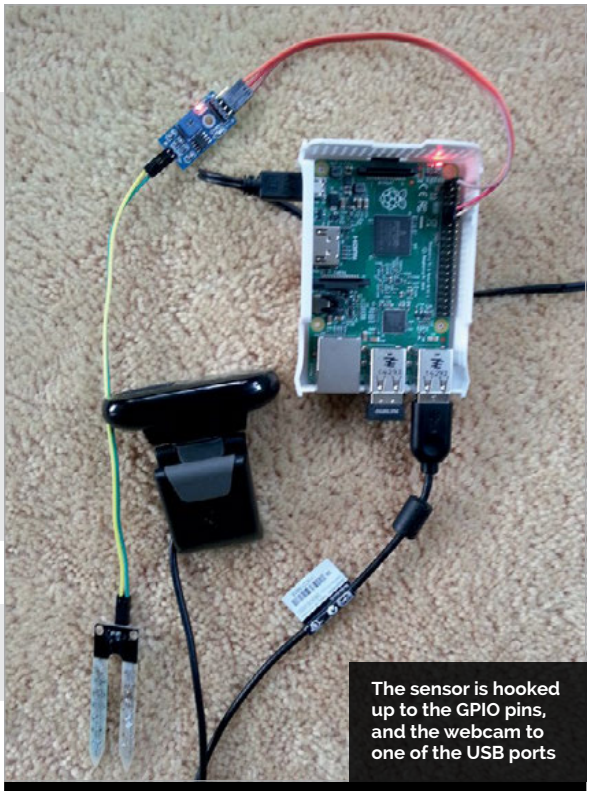
And finally:

```
  vi /etc/default/motion
  start_motion_daemon=yes
```

Restart the Motion service with **`sudo service motion restart`**. Always keep in mind that you can use the **`update-rc.d`** command to ensure that a program starts automatically after a fresh boot:

```
  sudo update-rc.d motion enable
```

When Motion saves video or JPEG files, they are stored in the **/var/lib/motion** folder. By default, the



WEBCAM

Check the Raspbian compatibility of any webcam before purchase. You'll find a list of Pi-compatible webcams at **magpi.cc/2gVs35G**.

MOISTURE DETECTION

The system works best at detecting new water saturation, rather than measuring the ongoing moisture percentage with precision.

HYDROPONIC FEEDING INTERVALS

Use a timer to run one, two, or more predictable feeds per day.

The Pi keeps an eye on the garden and helps the author to check on it from remote locations

REMOVE OLD IMAGES

Remove JPEG images from the **/var/lib/motion** folder from time to time to free up disk space for future images.

files are timestamped, and the most recent file is always titled **lastsnap.jpg**, which makes the file system easy to work with.

During a Motion installation, it is likely that the folder where the files are saved will need new permissions. To give that folder owner and group permissions for Motion, type:

```
chown -R motion:motion  /var/lib/motion
```

At this stage, you should be able to access the Raspberry Pi from a browser (**http://local_pi_ip:8081**) and see the streaming webcam video – even after a reboot.

Home web server

WIFI AUTO-CONNECT

To work effectively, the Pi should always use the same network IP address to connect to your WiFi.

A home web server is the easiest way to access the most up-to-date picture of the garden from a remote location. It also allows you to interact with the moisture sensor. To access your home server, type the home IP address into your browser. If you don't know your IP address, you can find it at **iplocation.net**.

It only takes a few commands to install a web server and PHP, and make your Pi into a home server. To keep this tutorial simple, the following commands show how to install the Apache web server and PHP:

```
  sudo apt-get update
  sudo apt-get install apache2
  sudo apt-get install php7.0 php-pear
libapache2-mod-php7.0 php7.0-mysql
  sudo apt-get install php7.0-curl php7.0-
json php7.0-cgi
```

With these packages installed, you should be able to view the new website at your IP address via a browser or with a free online proxy. Make sure your router can forward port 80 to let you see the webpage, and optionally port 8081 for live streaming.

Monitoring water

The soil moisture sensor is a common Pi add-on, and hooking it up is easy. The moisture sensor board connects to three GPIO pins on the Pi: GPIO 17, power, and ground. The sensor board is also connected to the metal plates of the moisture probe.

The unit works straight away – all you need to do is stick the probes into a pot. If you see only one light on the sensor board, add some water. After adding water, you should see two lights. In our experience, the moisture detection light illuminates after watering, but the sensor board can go down to one light within an hour, even though the soil or growing medium has retained some moisture. You can use

this system to make sure a scheduled watering has happened.

The script used in this project to detect moisture uses PHP. PHP has a **shell_exec()** function that allows the easy use of Linux shell commands instead of using a GPIO library. Find the code in the code listing box.

Remote access

Let's start tying everything together. We have a script that detects watering, and lets us know if watering is on or off. Watching this is very easy: just open the page in a browser.

Since seeing is believing, viewing the **lastsnap.jpg** file lets you see how the plants are doing at any time. This image is saved to the **Motion** folder, and you can set up a cron job (use **crontab -e**) to move this file to the HTML folder and display it in the browser:

```
* * * * *  cp /var/lib/motion/lastsnap.jpg
/var/www/html/test.jpg && chown pi:pi /var/
www/html/lastsnap.jpg
```

The resulting page shows the live stream, the most recent image, and a message reporting the results from the sensor. Save the URL to your phone and open it at will. You can display your data as shown in this tutorial, or just set up the parts you want to use.

Hydroponics basics

Although the focus of this article is about monitoring the plants, it is helpful to know a little about vertical hydroponics, which uses interlocking quad pots stacked on top of each other.

When growing, tomatoes can be stacked two or three pots high; lettuce, cucumbers, and peppers do well with five or six pots stacked up. The stacking gives very high yields per square foot.

To feed the plants, nutrients are delivered using a pump that sends liquid nutrient through half-inch polythene tubing. Along the half-inch header line, barbed fittings are inserted so that quarter-inch tubing can send fluid to each pot. Irrigation into the pots takes place slowly, regulated by drippers inserted into the ends of the pipes.

Plant stakes are used to hold the drippers in place. At the very bottom of the system are individual three-gallon (11-litre) pots that catch the waste nutrient. These bottom pots also hold plants.

In each pot, you can use a medium like soilless mix, coco coir, peat/perlite mix, or even well-draining dirt. As far as feeding is concerned, any hydroponic plant fertilizer is fine – powders are often much cheaper than liquid. A food-grade 55-gallon (208-litre) drum makes a good, cheap, food-grade nutrient tank.

When you mix a nutrient solution, a pH pen and EC/TDS (total dissolved solids) meter will help to fine-tune the plant diet. You can cut costs by using pH test strips or a liquid pH test solution. Normally, your water and mix pH values will be consistent, so you shouldn't need to test them very often. A pH of 6.0-6.5 works for most vegetables, while 1500-1800 ppm (parts per million) TDS indicates a decent fertilizer salt concentration. When growing lettuce, a lower TDS value (400-500) may be sufficient.

Hydroponically grown produce can yield big harvests and lots of growth, so be ready to supply some support for your giant plants! On the other hand, lettuce is easy to care for, and many varieties of tomatoes will trail downwards without requiring any support.

As well as producing plenty of pesticide-free food all year around, a growing garden can bring enjoyment and peace to your home.

index.txt

Language
>PHP

DOWNLOAD:
magpi.cc/2gVYroO

```
<img src="http://local_ip_with_
motion_service:8081/" width="320"
height="240"/>

<img src="lastsnap.jpg" width="320" height="240"/>

<?php

$on_off = shell_exec('gpio read 0');

echo $on_off;

if($on_off == 1){

echo "<br/>It is off";

}else{

echo "<br/>It is on!<br/>";

}

?>
```

Above The author in his vertical garden, which requires less than ten minutes of maintenance every day

FREQUENTLY ASKED QUESTIONS

NEED A PROBLEM SOLVED?

Email **magpi@raspberrypi.org** or find us on **raspberrypi.org/forums** to feature in a future issue.

Your technical hardware and software problems solved...

USING YOUR RASPBERRY PI AS A SERVER

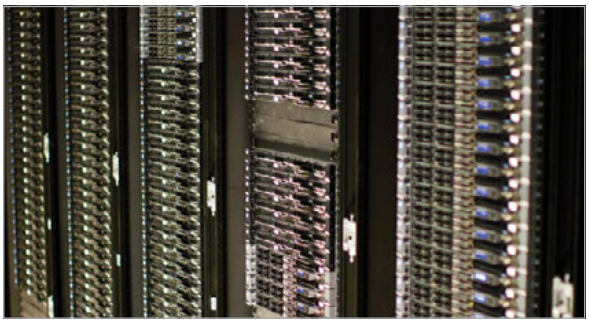


Image credit: CC-BY-SA-3.0: Victorgrigas

WHAT IS A SERVER?

Conventional server

Think of a server as a big computer that smaller computers, such as your desktop or Raspberry Pi, communicate with to get information. This could be online, to open a website, or to download a file from your favourite cloud service. They're generally more powerful, and have much more storage, than an average PC.

Home server

A home server is a scaled-down version of an online server. On a home network, where only a few devices will be accessing it at any one time, you don't need a very powerful system to act as a server. In fact, most home servers are less powerful than a desktop PC, and it is common for people to use an old PC as a server.

Raspberry Pi server

A Raspberry Pi may not be powerful enough to use as a conventional server, but it is perfect for use at home or in a small office. Using a spare Pi to serve files and media to your network can be a great and cheap way to meet your file storage and sharing requirements.

HOW DO I BUILD A RASPBERRY PI SERVER?

Storage

You'll need to add extra storage to the Raspberry Pi if you want to use it as a server. Depending on your requirements, you could use a large USB flash drive or a USB portable hard drive. The hard drive may be slower, but it will allow for constant writing and rewriting.

Operating system

You'll find plenty of tutorials demonstrating how to set up a server using Raspbian, but there are other operating systems for the Pi that offer server-specific tools. Arch (**magpi.cc/2nf6YFk**) and Fedora (**magpi.cc/2miaZUL**) are highly customisable and secure; Chromium OS (**magpi.cc/2njuVeS**) offers a web kiosk setup; and PiBox (**magpi.cc/2x4nutO**) is optimised for use as a media server.

Networking

The built-in wireless LAN on the Raspberry Pi 3 and Pi Zero W is faster than a wired Ethernet connection. A wired connection will be more stable, but may involve trailing wires around your house. You'll need to decide what will work best for you.

WHAT ARE THE BENEFITS OF A RASPBERRY PI SERVER?

Low power

The Raspberry Pi draws very little power, so you can leave it running 24/7. Linux-based operating systems are very stable, so a Raspberry Pi server is well equipped to run for long periods of time.

Size

Even the largest Raspberry Pis are only the size of a credit card, giving your Pi server a very small footprint. The Pi Zero is even smaller, and some makers have created home servers where the Zero is built into the mains plug that powers it (**magpi.cc/2y3dNLP**).

Community

Want to set up your Raspberry Pi server? The Raspberry Pi community is very active, and provides tutorials and solutions for almost any problem, including specific server setups. You may even find suggestions in the forums that you hadn't thought of, which will make your computing life even easier.

FROM THE RASPBERRY PI FAQ
RASPBERRYPI.ORG/HELP

WHY IS THERE NO REAL-TIME CLOCK (RTC)?

The expectation is that non-network-connected units will have their clocks updated manually at startup. Adding an RTC is surprisingly expensive once you have factored in batteries, area, and components, and would have pushed us above our target price. You can add one yourself using the GPIO pins if you'd like an interesting electronics project.

WHY DOESN'T THE RASPBERRY PI INCLUDE <INSERT NAME> PIECE OF HARDWARE OR <INSERT NAME> SORT OF PORT?

Our main aim is a charitable one: we are trying to build the cheapest possible computer that provides a certain basic level of functionality, and keeping the price low means we've had to make hard decisions about what hardware and interfaces to include.

CAN I ADD EXTRA MEMORY?

No. The RAM on the Model A, A+, B, B+, and Zero is a Package on Package (PoP) on top of the SoC, so it is not removable or swappable. The RAM on the Pi 2 and 3 Model B versions is on a separate chip on the bottom of the PCB, but 1GB is the maximum RAM that the SoC used by the Pi 2 and 3 Model B versions can support.

WHAT IS ITS OPERATING TEMPERATURE?

The Raspberry Pi is built from commercial chips which are qualified to different temperature ranges; the LAN9514 (LAN9512 on older models with two USB ports) is specified by the manufacturers as being qualified from 0°C to 70°C, while the SoC is qualified from -40°C to 85°C. You may well find that the board will work outside those temperatures, but we're not qualifying the board itself to these extremes.

KEEP MULTIPLE PROJECTS IN ONE PLACE

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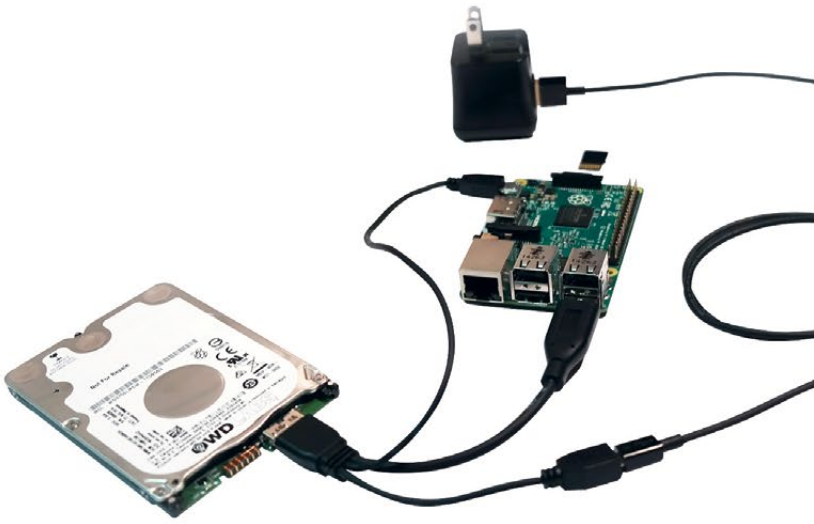

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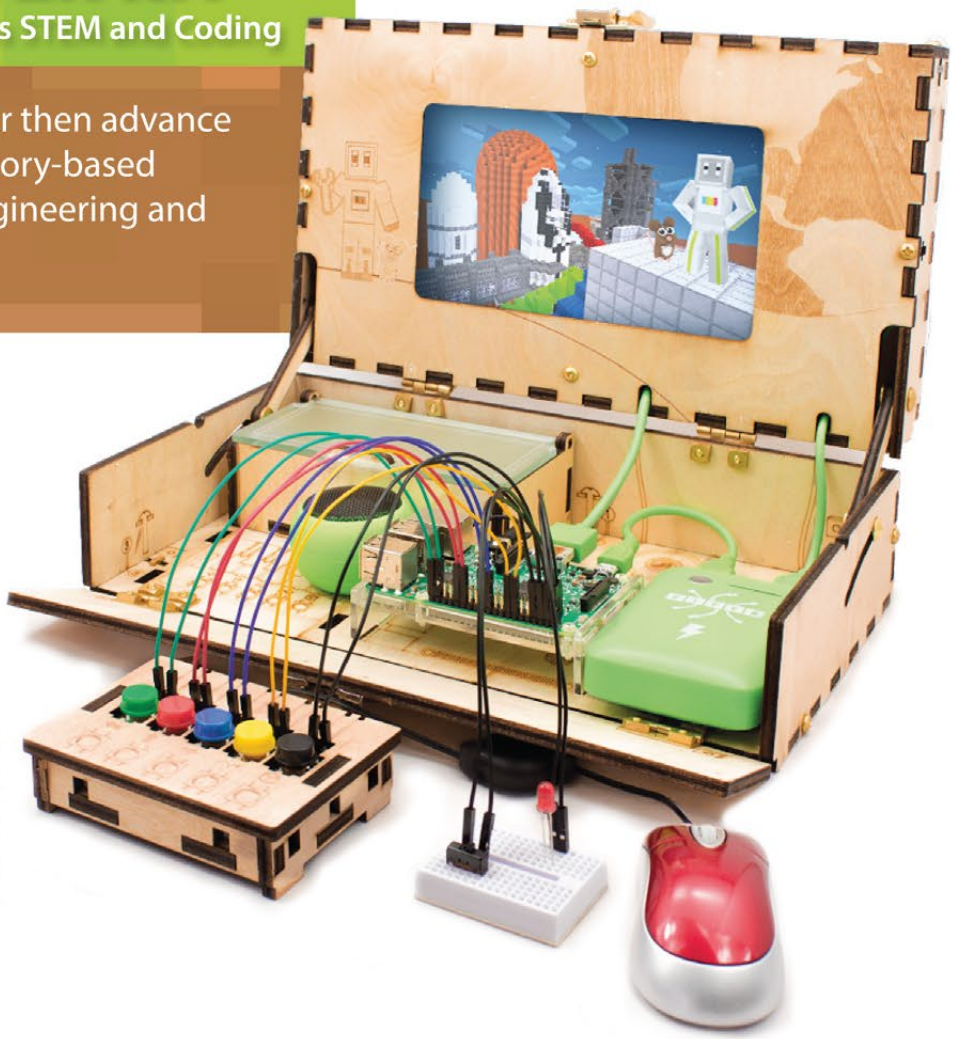

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"It's a really fun educational computer kit that should really impress those who love Minecraft and building stuff" The MagPi

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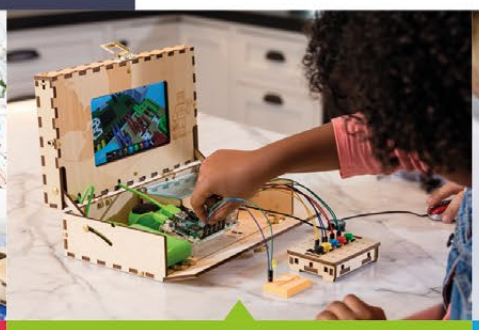

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WEEKEND PROJECTS

GOT A GAP IN THE DIARY?

FILL IT WITH AN AWESOME RASPBERRY PI PROJECT.

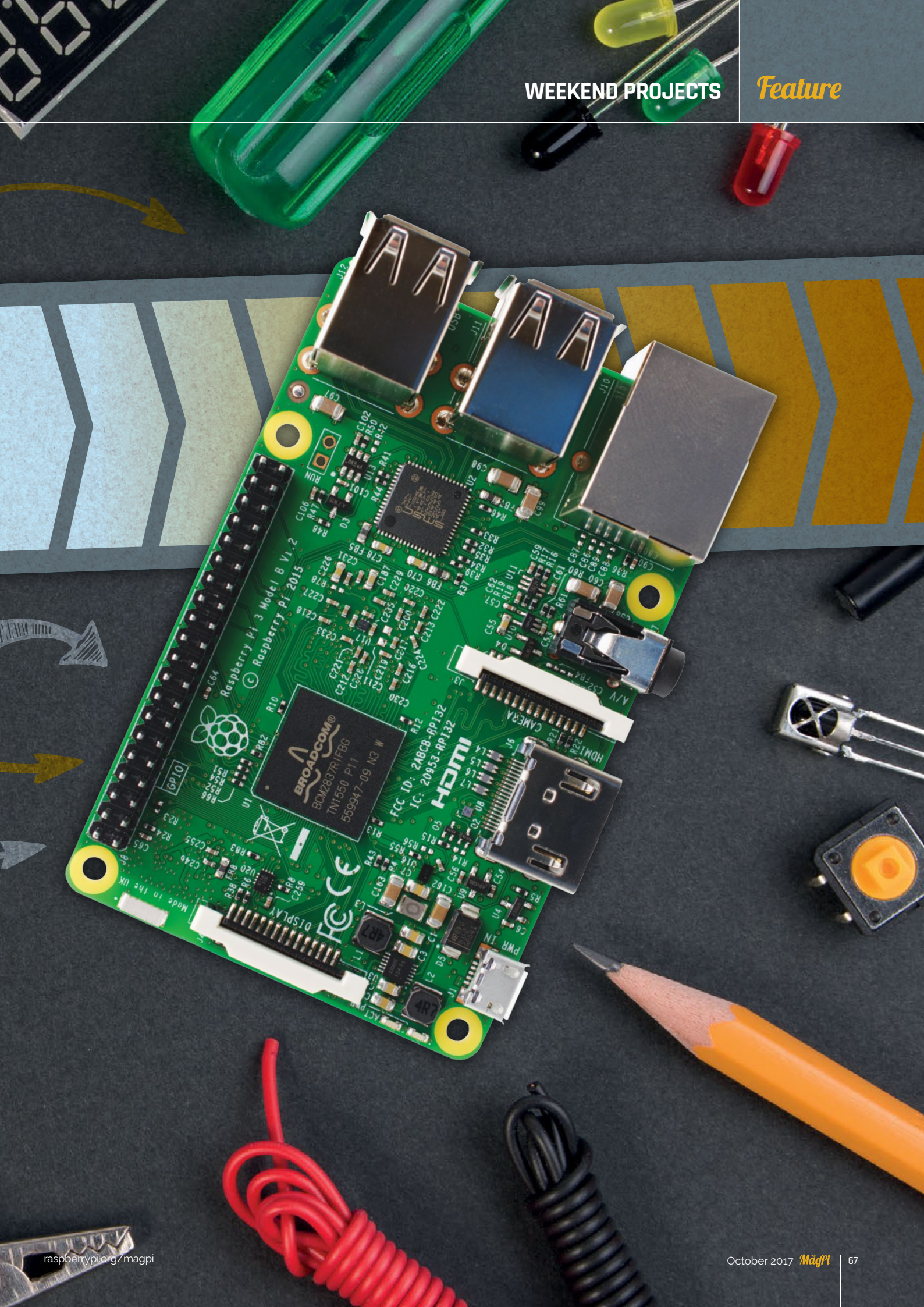
What will you say when your friends and colleagues ask you what you did at the weekend? Watched a film, went out for lunch, or had a lie-in?

Give them a better answer: in this project roundup we show you what you can achieve in two days. You could build a robot, upgrade your family's toys, or fashion a sparkling bag. You could connect your fridge to the Internet of Things, or hack a stereo to play your theme song when you walk into the room.

Many of the projects are family-friendly, so younger makers can join in. Let's get started!

LET'S GET MAKING!

Grab your tools, toys and Pis, and make something amazing this weekend!


Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
BROADCOM
BCM2837RIFBG
TN1550 P11
559947-09 N3 W
FCC ID: 2ABCB-RPI32
IC: 20953-RPI32
HDMI
GPIO
DISPLAY
Made in the UK
PWR IN

MAKE A SMART FRIDGE

DO YOU NEED TO BUY MORE BEER, OR IS SOMEONE AT HOME STEALING YOURS? LET YOUR FRIDGE TELL YOU, USING A WEB DASHBOARD.

JAMIE BAILEY

Jamie is the CEO and founder of Initial State. He has 16 years of experience in product development, integrated circuit (IC) design and testing, embedded systems, and software development.

magpi.cc/2xyo28v

Here's a cool project: a drinks fridge that uses a scale to work out how many bottles are inside, a temperature sensor to help you keep the beers chilled, and another sensor to detect when the door is opened. The data can all be streamed to a web-based dashboard.

Jamie Bailey conceived the project as a way to stop his house-sitting 19-year-old nephew from stealing his beer. Now, if a bottle is removed from the fridge, Jamie gets a text message and can call his nephew to warn him off before the bottle is even opened.

"I decided early on that a web-connected scale was going to be an effective, non-intrusive way to make my beer fridge 'smart'," Jamie says. "I didn't want to drill any holes in my fridge or worry about communicating with electronics from inside a closed, cold box. Finding a web-connected scale was frustrating because there really weren't any products on the market that I could use. Once I figured out that I could hack a Wii Balance Board to talk to a Pi, the project was truly a go."

The Balance Board sits underneath the fridge and connects to the Pi over Bluetooth. By knowing the weight of the fridge and the weight of a bottle, Jamie's Python code can work out how many bottles are inside the fridge.

Data is streamed to a dashboard designed by Initial State, the company Jamie founded, which provides graphs and the ability to trigger a text message alert.

"It was so cool to take something that I already had and turn it into a data collecting, peace-of-mind appliance that no one else in the world had," Jamie says. "It has been such an awesome conversation piece when friends and family come over."

Visit the link for a detailed guide, including the code to create your own smart fridge. Cheers!

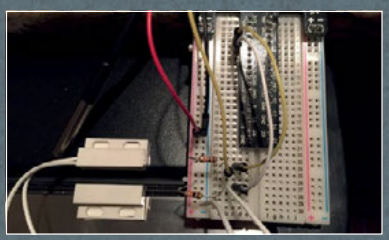
MAKE YOUR FRIDGE SMART

ADD THE SCALES

You can't pair the Balance Board with the Pi permanently. Use a pencil as a lever so you can press the sync button, even with the fridge on top.

ADD THE SENSORS

The magnetic contact door sensor connects to the Pi through a breadboard, with a 10 kΩ resistor. The temperature sensor sits inside the fridge, with the wires running through the door seal.



STREAM DATA

You can stream data to an Initial State dashboard in JSON format or with URL parameters. Download Jamie's code to test your sensors and set up your fridge.

TALKIEPI

DO YOU WANT TO MAKE INTERNET-CONNECTED WALKIE-TALKIES FOR ALL THE FAMILY? THAT'S A BIG TEN-FOUR!

Watching Netflix series *Stranger Things* inspired Daniel Chote to make some "big ol' 1980s walkie-talkies" for his family. His children Eddie (6) and Ollie (3) can use them to chat to each other, and to their friends, through an internet-based server.

The software core is Mumble, an open-source voice chat system designed for use by PC gamers. There are clients for a range of operating systems, so the TalkiePi, as Daniel has named his project, is compatible with many other apps and devices. The software can be used to connect groups of people who can chat to each other, like using channels on a traditional walkie-talkie.

Daniel used a US Robotics USB Speakerphone, which sells for less than $12, as the heart of his device. He removed its case and connected its board to one of the Raspberry Pi 3's USB ports.

He wired up some simple components to the Pi's GPIO pins: a push-button to use when talking, and two status LEDs at the bottom of the speaker. One is illuminated when you're connected to the Mumble server, and the second lights up when other people are in the chat room. A third LED inside the button lights up when the TalkiePi is sending your audio.

Daniel designed a case to house the device using Autodesk's 3D CAD software Fusion 360. The case was printed using a Monoprice Select Mini 3D printer.

For now, the device is powered using a wall socket, but possible enhancements include portable power.

You can find Daniel's code and 3D-printable design files at **magpi.cc/2vKbHP3**.

Daniel's advice to other makers? "Keep it simple – be creative," he says. "Don't be afraid to learn new programming languages, or even something like Fusion 360 for CAD."

Roger that!

DANIEL CHOTE

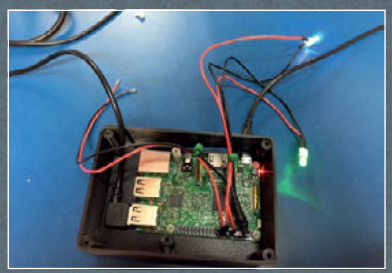
Daniel is a believer that everyone can learn new things. If something interests you, there really isn't anything stopping you from attempting to do it yourself.

magpi.cc/2vsqMtx

MAKE YOUR OWN TALKIEPI

SOLDER THE LEDS

Connect the push-button. Solder the status LEDs to wires, and connect those wires via 330 Ω resistors to your GPIO pins. Daniel uses a GPIO header connector.



ADD THE SPEAKER AND MIC

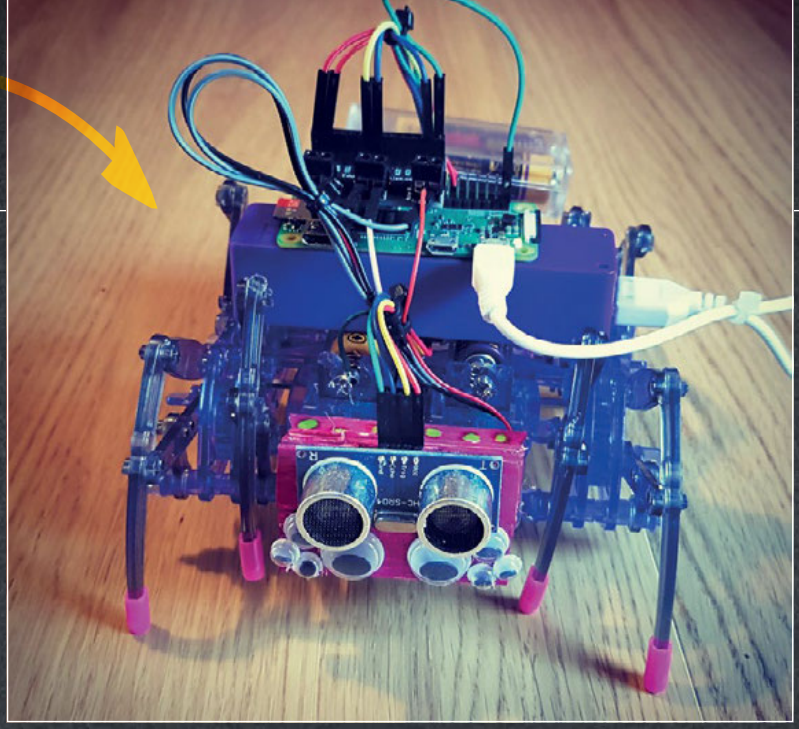
Unscrew the speakerphone. Connect a right-angled mini USB cable to the Pi's USB port. Use it to connect the speakerphone's circuit board to the Raspberry Pi.

MAKE A CASE

You can 3D-print Daniel's design. If you don't have a 3D printer, you can make your own case from cardboard or LEGO, or use the project without a case.

MAKE A ROBOT

MAKE A ROBOT IN A WEEKEND, WHETHER YOU'RE MAKING YOUR FIRST OR ADDING TO YOUR ARMY



When Mark Norwood saw a £5 spider robot toy in Tiger, he thought: "That would make a great Raspberry Pi project for someone! Hey, that someone could be me!"

The toys scuttle forwards when the power is on, but now Mark has joined two of the toys together to create a spider that can walk forwards and backwards, under the control of a Raspberry Pi. The robot, Mr Nancy, uses the right legs from one toy and the left legs from another, so they can be controlled independently.

The robot is based on the Raspberry Pi Zero W. Mark uses parts from the CamJam EduKit 3, which provides everything you need to make a simple robot – in particular the motor controller board which enables the Pi to control the motors. The Raspberry Pi is powered using a power pack from Poundland, while four AA batteries drive the legs.

For the software, Mark used a combination of Scratch for line-following, and Python for the distance sensor and obstacle avoidance. He uses RealVNC on his Chromebook to view the user interface running on the Pi Zero.

This is Mark's second robot based on the CamJam EduKit 3, following his Robocroc which motorised a plastic shoe. "The kit is cheap, and has everything you need, with good instructions on the CamJam site," he says. "Everyone in the community knows it, so they can give you help if you need it."

He found the GPIO Zero examples on the Raspberry Pi website helpful, and his advice to others building robots is to "dabble with GPIO Zero, because it massively reduces the amount of coding you have to do."

Mark's website includes a detailed photo essay showing the construction of Mr Nancy, and you can find out more about the CamJam kit at **magpi.cc/2xxPy8X**.

MARK NORWOOD

Mark Norwood is a teacher working in Bedfordshire, specialising in teaching young people with behaviour problems. In his spare time he walks, he dreams, and is a Cub Scout Leader.

magpi.cc/2vsnhDs

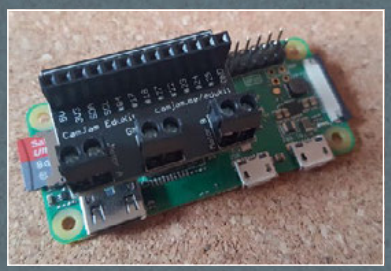
BUILD YOUR OWN ROBOT

CHOOSE YOUR CHASSIS

Mark used two of these spider toys for Mr Nancy, but you could build a robot using a pencil case, a cereal box, or a LEGO design.

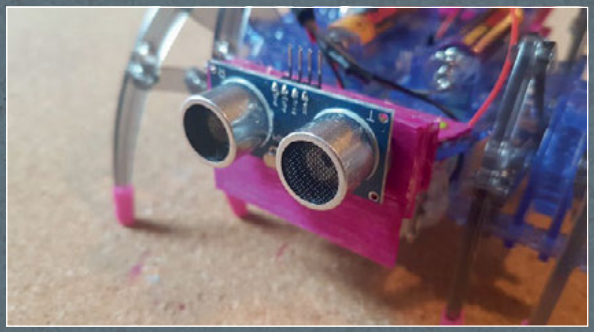
ADD THE MOTOR BOARD

The motor controller board from the CamJam kit sits on your Pi's GPIO pins. Wire your motors into the left and right terminal blocks, and your motor battery to the middle block.



ADD ADDITIONAL SENSORS

This distance sensor comes from the CamJam kit, and a line-following sensor is also included. Use the CamJam software to test them and add them to your robot.



TRIGGER YOUR THEME SONG WITH DOORJAM

MAKE YOUR FIRST IMPRESSION COUNT BY TRIGGERING YOUR THEME SONG AS YOU ENTER THE ROOM

MATT REED

Matt Reed is a creative technologist at agency redpepper.

magpi.cc/2wisSL6

As you walk through the door, the bass starts pumping and all heads turn to look. You're here, so it's time to get the party started!

You're using Doorjam, which triggers your theme song as you enter the room. It works like this: a Raspberry Pi 2 emits a Bluetooth Low Energy iBeacon signal, which can be detected by an iPhone. The Bleno Node package enables a USB Bluetooth dongle to act as an iBeacon.

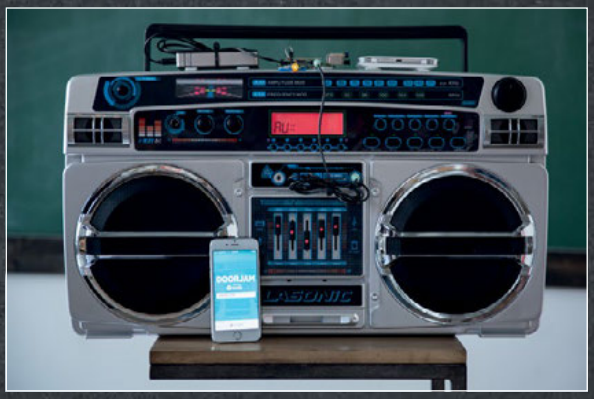
On the phone, an app detects the iBeacon and sends a signal to a control server containing the Spotify ID of the user's song, and the ID of the iBeacon that has been found. The server uses Node.js to push a command to the Pi to tell it to play the music. Having the server means that you can use the setup to coordinate a whole network of iBeacons across your building or town.

"Bluetooth beacon ranging is noxiously jumpy," says Matt Reed, who made the project. "An app may think you're between three and ten metres away from a beacon at any given second. The Bluetooth received signal strength indicator (RSSI) value is affected by obstacles and other radio interference. I overcame this by using an easing equation to smooth the distance proximation to the beacon. This slows down the detection but makes it more accurate, because you're not out in the parking lot while your theme song is playing inside."

This weekend project is best suited to those with some Node.js experience, but Matt's blog includes essential code snippets for the Pi and the phone.

What is Matt's choice of tune? "*I'm on a Boat* by Lonely Island Boys," he says. "Don't ask me why, I just love that song and it makes me laugh every time."

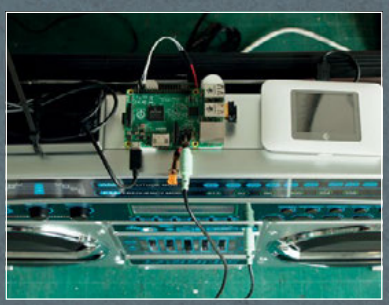
What will your tune be?



MAKE YOUR OWN DOORJAM

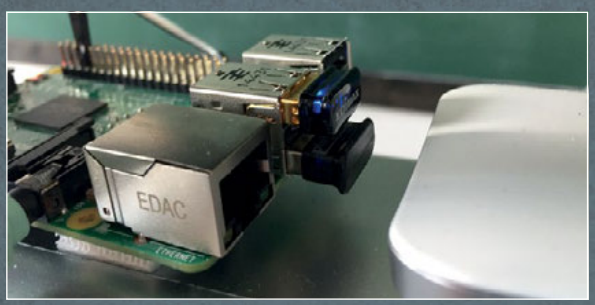
CONNECT THE PI

The Pi's audio out goes to the boombox's audio in. A power supply (left) and 4G hotspot (right) on the top enable the unit to work anywhere.



CONNECT BLUETOOTH AND WIFI

Matt used a Raspberry Pi 2 because he had one handy, so he added dongles for wireless and Bluetooth connectivity. You might prefer to simplify the project by using a Pi 3 with wireless and Bluetooth connectivity built in.



MAKE YOUR TRIGGER

The app (built using PhoneGap) enables users to look up the ID of their Spotify song, and tracks the distance to the iBeacon when it is detected. At less than 10 ft (3 m), it cues the music.

6 EPIC WEEKEND PROJECTS

MORE IDEAS TO ROUND OFF YOUR WEEKEND IN STYLE

PIX-E GIF CAMERA

Nick Brewer and his wife Shayna designed a Pi Zero camera for recording animated GIFs. The power comes from a LiPo battery connected to a PowerBoost 500C to boost its output to 5 V. A button connected to the GPIO is used to trigger the photo, and an LED lights up while the GIF is being recorded. The camera has a 3D-printed case design, and printable paper wrap-arounds to make it feel like a disposable film camera.

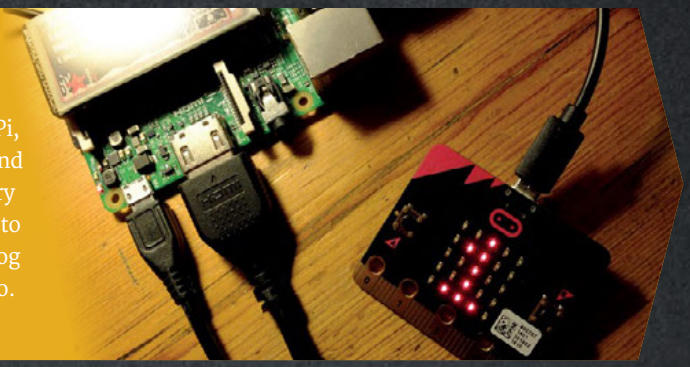
magpi.cc/2vuEBaK

PI TOTE

Amanda Haughs designed a tote bag with a Pi Zero concealed in a pocket. It controls seven 5 mm clear white LEDs in the embroidered Raspberry Pi logo, which light up in a random order. 8-inch female-to-female jumper cables are used to connect the LEDs to the Pi and resistors. Amanda used GPIO Zero to pulse the lights, and a cell battery for power. The **rc.local** file was edited so that the program runs when the Pi boots.

magpi.cc/2vrVIKB

MICRO:BIT-CONTROLLED RADIO



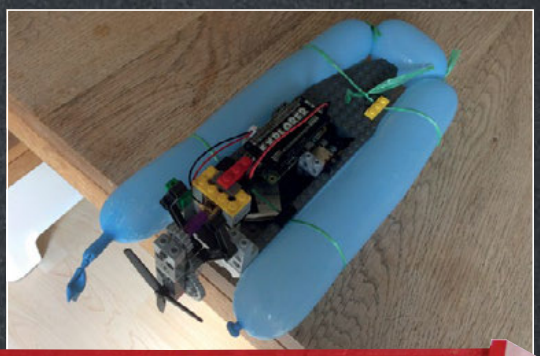
Giles Booth made a radio controlled by a BBC micro:bit, using the buttons to change stations and the tilt control for volume. The micro:bit also displays the station number. Giles used David Whale's **bitio** Python library to access the micro:bit from the Pi, and **mpc** and **mpd** to configure and stream the stations. The **os** library is used to send MPC instructions to the command line. See Giles's blog for instructions, code, and a video.
magpi.cc/2xNc39m

THE SMART PHONE

Simon Jackson put the Google AIY Projects Voice Kit into a Fisher-Price telephone, creating a more interactive toy for his six-year-old son Owen. The biggest challenge was getting all the components to fit into the housing. "I had to source a smaller speaker to save on space. Then the only way I could get the Pi to fit was to cut the rear wheel arches with a soldering iron hot knife tip," he says.
magpi.cc/2es19Sj

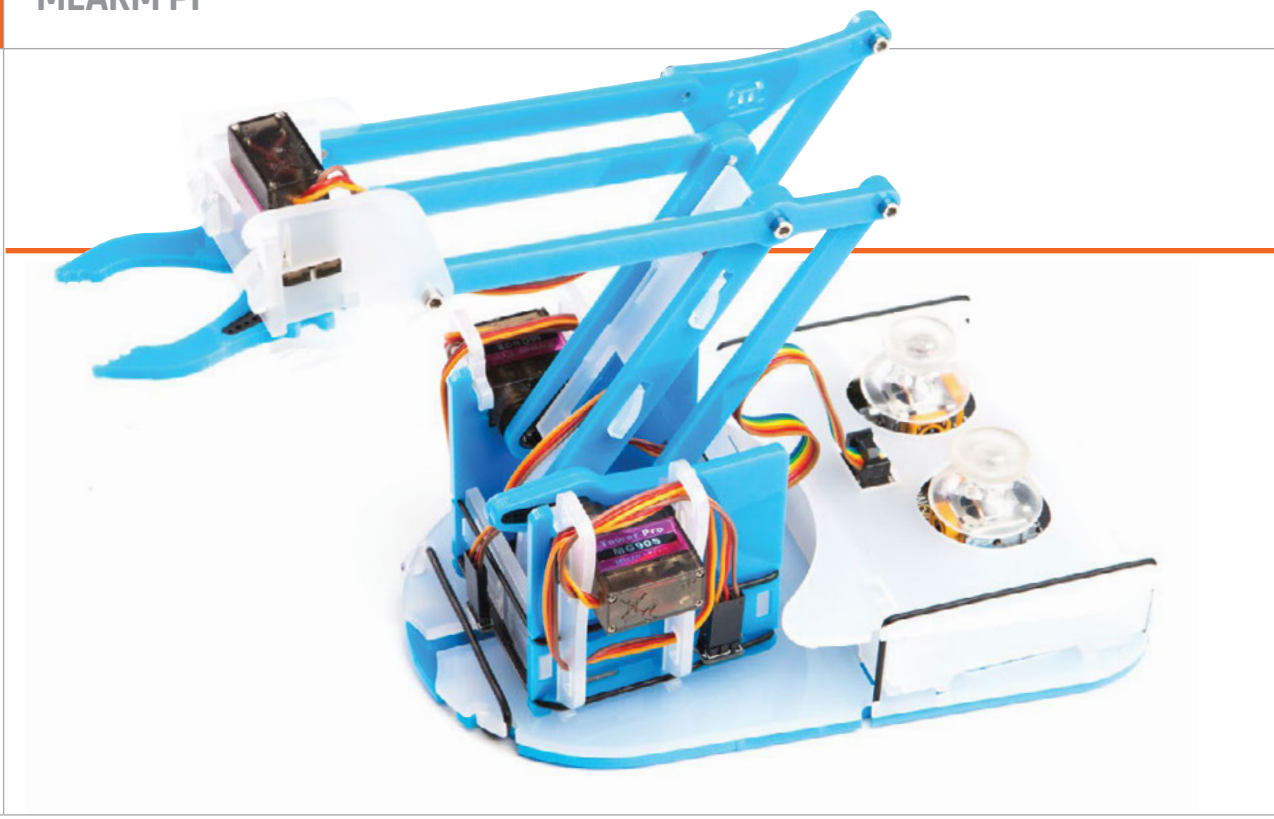
LEGO BOAT

Ten-year-old Ozzy Hayler made a Pi-driven LEGO boat, using a balloon for buoyancy. The Pi Zero uses the Explorer pHAT as a motor controller, and it drives a micro metal gearmotor. Power comes from a LiPo battery and LiPo shim. The **remote pins** function of the GPIO Zero library is used to control the Pi from a laptop. "Keep the motor and Pi dry," he advises. "I tested it in a bowl of shallow water first."
magpi.cc/2grYg4l



ARCADE MACHINE

With Lakka and Recalbox in NOOBS, and RetroPie readily available, there are lots of software options if you want to play the games you grew up with. There are several controller options, too: Pimoroni's Picade supports joysticks and arcade buttons, and The Pi Hut makes a SNES-style gamepad. Nate Douglas made this arcade cabinet based on RetroPie using a Pi 3, half-inch medium density fibreboard (MDF), a Samsung 22-inch LED monitor, speakers, and a keyboard.
magpi.cc/2vuCZhc



Maker Says

"An easy-to-build robot arm kit that's designed to get children learning about technology, engineering, and programming

Mime Industries

MEARM PI

This fun robot arm will grab the interest of children and adults alike

Long-time readers of *The MagPi* may recall that we reviewed the original MeArm back in issue 33. While we loved the concept of an affordable, open-source robot arm, we did note that a missing piece of the puzzle was the need for users find their own way to drive the servos from a Raspberry Pi. The new MeArm Pi solves the problem by including a HAT with twin on-board joysticks, so now you have everything you need in one kit.

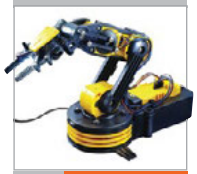
Below The joystick controls are on a HAT that slots easily onto the Raspberry Pi

Not only that, but the arm itself has been completely redesigned, eliminating two-thirds of the screws and using new fixings to make it easier to build. It certainly is a lot of fun to put together, like a cool motorised Meccano set. Step-by-step illustrated instructions are supplied online – two versions, for a standard-size Pi or a Pi Zero. Most of the acrylic pieces simply slot together, secured by a few rubber bands, while three lengths of screws are used for the moving joints. A hex key is supplied for this purpose, but you need to avoid overtightening the screws so that the joints can move freely. The design is well thought out, with strategically placed holes for the servo cables to pass through to keep them tidy. We found the trickiest part was sliding the arm

Related

MAPLIN ROBOTIC ARM

Connected via a USB port, this robot arm can be controlled from a Raspberry Pi using the PyUSB module in Python.

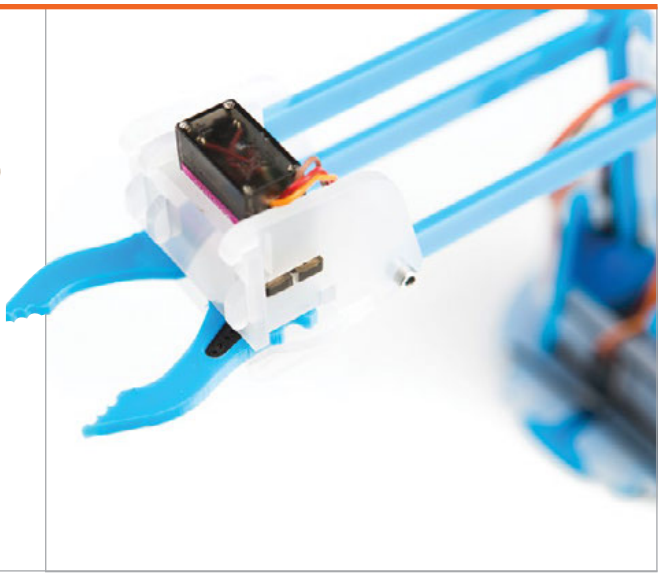


£55 / $73

magpi.cc/2dLweuN

magpi.cc/2waqp7b

£70 / $95



into the base, which required prising the two layers apart; we also needed to loosen the base servo horn slightly to enable it to move freely.

The case that houses the joysticks also features cut-outs for the Pi's ports, although there's no easy access to the SD card, so you'll need to download and write the special OS image to it before you enclose the Pi. Based on Raspbian, the OS includes all the required software and creates a wireless access point so that you can connect to and program the MeArm Pi directly from a remote computer or tablet. This means it can be used headless, without the need for a monitor, keyboard, and mouse. There's also the option of connecting it to your WiFi network if you prefer.

Twist your arm

Once the system has booted up, which takes about 75 seconds on a Pi 3, the arm jerks into life and you can then control it using the twin joysticks. This is a lot of fun – like controlling a mini digger, albeit with a claw. The left stick handles base rotation and lower arm movement, and the right stick controls the upper arm and claw grip. While the servos are pre-calibrated to be used out of the box, we did encounter an issue with the grip not closing fully at first, but this was easily rectified by unscrewing and repositioning the servo horn. There is quite a lot of buzzing from the servos, but we found the control was accurate enough for us to pick up small objects, such as cherry tomatoes and socks.

> "Most of the acrylic pieces simply slot together, secured by a few rubber bands"

A more interesting and educational way to control the arm is by programming it. While you can do this directly on the Pi, an easier way to get started is by connecting a PC or tablet to the MeArm Pi's local web server, by pointing a browser to **local.headlesspi.org**. This gives you access to four apps, each for a different programming language: Blockly, Snap!, Python, and JavaScript. These include functions (and sample code) for moving the arm's servos by degrees for accurate control. Naturally, you can set up loops and conditionals to get the arm to behave in sophisticated ways.

There's even the potential to add a Camera Module to the end of the arm (using an extra-long ribbon cable) and use OpenCV for image or face recognition to control it – as demonstrated by Mime (**magpi.cc/2ffXB2J**).

Last word

Despite a few teething troubles, we found the MeArm Pi a joy to build and use. Manual control using the joysticks is great fun, but programming it is ultimately more rewarding. The headless setup and local web server make it very easy to get started, offering a choice of four programming languages, although you could still opt to code it directly on the Pi instead.

★★★★☆

magpi.cc/2xpzdph

£14 / $18

Maker Says

"Perfect for all your Raspberry Pi gaming or robotics needs"

The PiHut

WIRELESS USB GAME CONTROLLER

This versatile controller is easy to set up and great to use

The Raspberry Pi 3 is an excellent base for retro gaming projects. With its speedy 1.2 GHz processor and wireless networking, you can set up a console in your front room and bounce ROMs to it from another computer.

Retro gaming consoles need a controller – arcade games are little fun to play with a keyboard and mouse. And if you're building a retro games console, this Wireless USB Game Controller is a great companion device.

The style will be familiar to Sony gamers. To our eyes, it's based on the PlayStation Dual Shock from the PlayStation One days. It features a D-pad, four buttons, two analogue control sticks, and four trigger buttons. In the middle are Select, Start, Analog, and a mysterious Turbo button.

All of this is powered by three AAA batteries, which we find easier than charging up via a USB cable. On the rear of the device is an on/off switch that is used to connect and disconnect from the Raspberry Pi.

The feature we like most is the 2.4 GHz Wireless USB receiver dongle. Instead of going through the awkward Bluetooth pairing process, you plug in the USB dongle, and it connects straight away.

We tested it with RetroPie and are pleased to report that it worked first time without any issues. As soon as we booted into RetroPie, the Wireless USB Game Controller appeared as a device, enabling us to assign buttons to controls. You will find a RetroPie video installation guide here: **magpi.cc/2doUHrd**.

During a game test, we found the Wireless USB Game Controller comfortable to hold and perfectly fine to use. It's not quite up there with the original Dual Shock, but it's not far off, and better than most third-party controllers.

You can also use the Wireless USB Game Controller to control robots – we looked at building a Remote Control Robot in *The MagPi* issue 51 (**magpi.cc/Issue-51**).

Related

USB GAMEPAD (SNES-STYLE)

Not wireless, but a classic SNES-style controller that's perfect for recreating classic gaming moments.

£6 / $8

magpi.cc/2ve6iUo

Last word

One of the best games controllers we've found. Works right out of the box and is a comfortable, professional, and slick piece of kit. A perfect companion for retro gaming.

★★★★★

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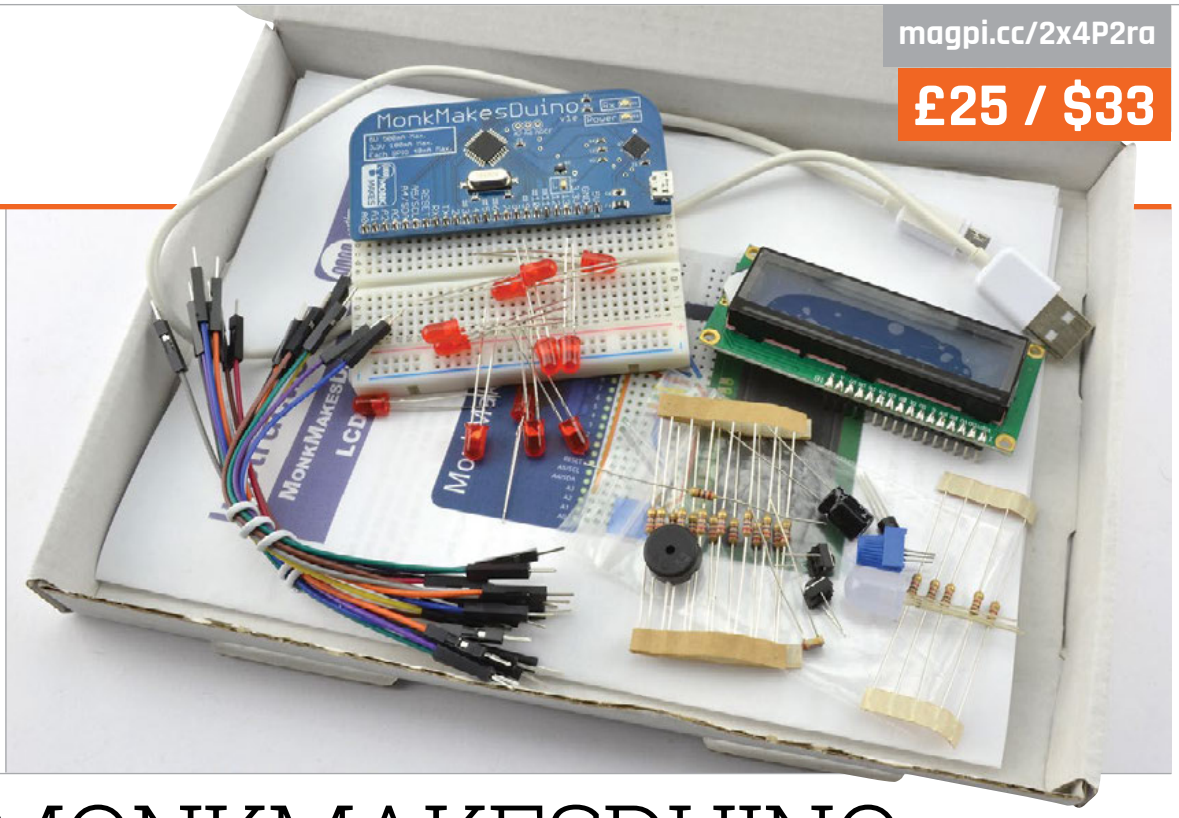
£25 / $33



Maker Says

"It will provide you with hours of entertainment, building projects, and learning how to program **MonkMakes**

MONKMAKESDUINO LCD KIT

Have fun programming in a new way with the MonkMakesDuino LCD Kit

While not specifically a Raspberry Pi product or project, the MonkMakesDuino LCD Kit is a great educational tool for coding, in a similar vein to the MonkMakes Pi kits that we've looked at in the past. In fact, with our feature from issue 61 about using the Pi to interact with Arduino, you can probably connect the two together.

Unlike the Raspberry Pi, which is a full computer, Arduino boards like the MonkMakesDuino are microcontrollers. You write code on another computer, which you then upload to the board for it to run. This has various advantages and disadvantages depending on how you use the board (for example, a microcontroller uses less power, but isn't as powerful). For this kit, it's just a different way to learn about coding and using electronics.

It's called the LCD Kit, as the main component it comes with is just that: a simple LCD screen. It's not a full-colour display, but a two-line text display with 16 characters on each line, allowing you to print simple messages such as a live temperature reading.

Being a MonkMakes kit, it also comes with much more than the board and LCD screen. Included is a selection of LEDs, buttons, sensors, and jumper wires, along with a breadboard, so you can try out different setups and projects. The quality of the included projects is fantastic, with easy-to-understand tutorials on how to create cool effects with the LEDs, and make a countdown timer on the LCD. There's a great online repository of code examples as well, so you don't have to type out everything by hand.

Thanks to the array of components, this kit will definitely be useful once you've finished with the instruction book – buttons and LCD screens are useful for many projects.

Last word

A great kit that will teach you another aspect of coding – while also having lasting use beyond the tutorials in the book, thanks to its great array of electronics components.

★★★★★

Related

DISPLAY-O-TRON HAT

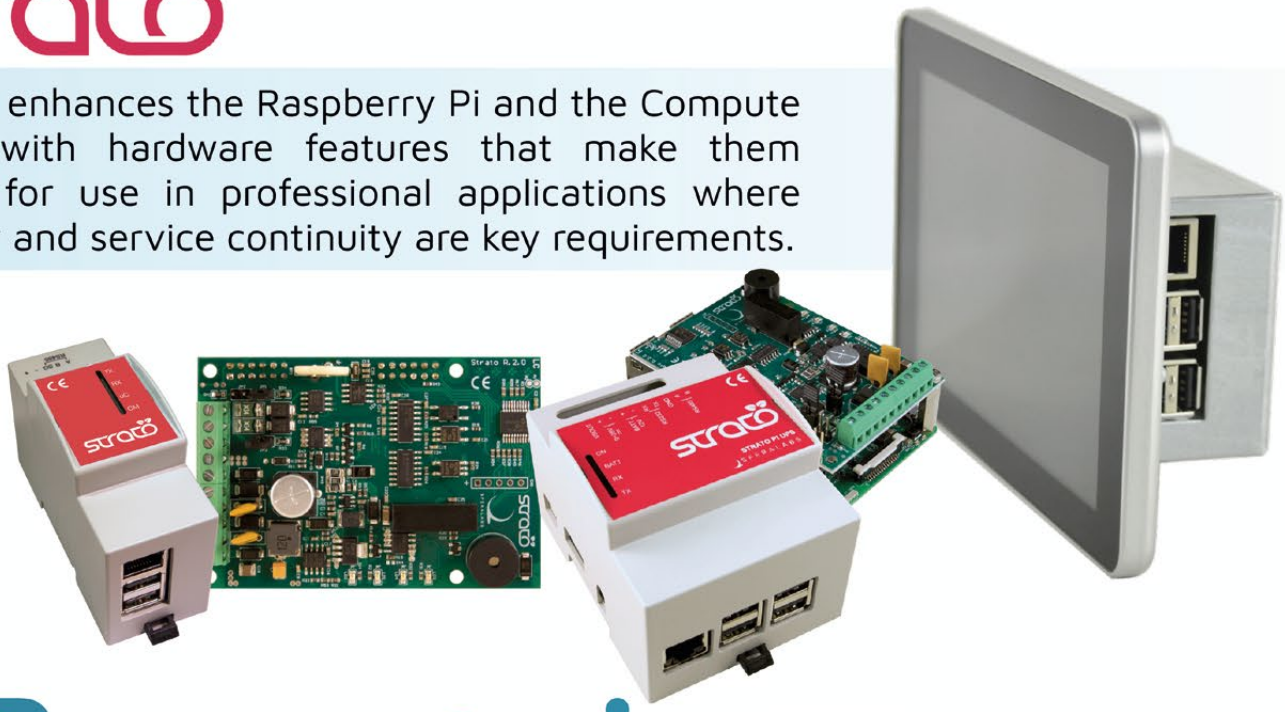
A HAT for the Pi with a three-line LCD display that is fun and easy to program.

£22 / $28

magpi.cc/2y3DM5C

Raspberry Pi for professional applications

Strato Pi enhances the Raspberry Pi and the Compute Module with hardware features that make them suitable for use in professional applications where reliability and service continuity are key requirements.



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- CAN BUS
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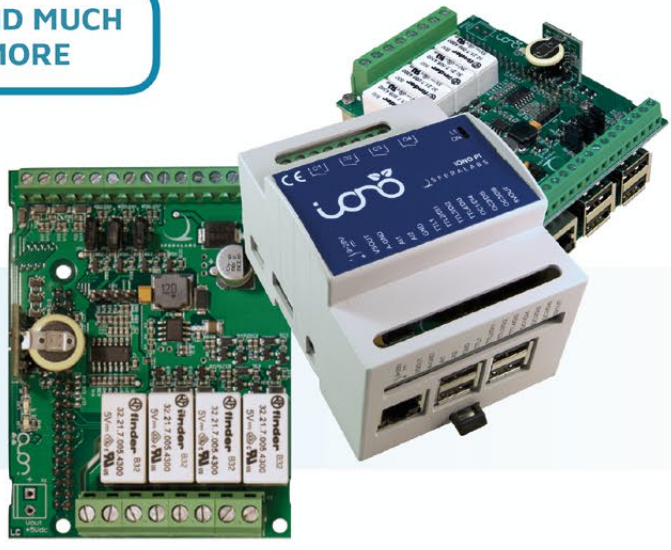
- .. AND MUCH MORE

Iono Pi is a versatile I/O module that combines digital and analog standard interfaces with the powerful computing core of the Raspberry Pi.



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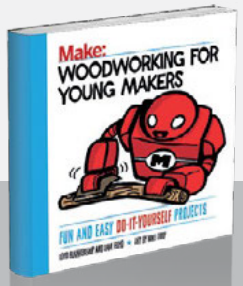
RASPBERRY PI BESTSELLERS

ACTIVITIES FOR KIDS

As the nights draw in, Make will entertain, educate, and upskill your children.

WOODWORKING FOR YOUNG MAKERS

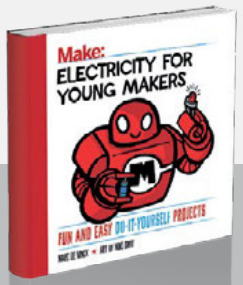
Authors: Loyd Blankenship, Lane Boyd
Publisher: O'Reilly
Price: £10.50
ISBN: 978-1680452815
magpi.cc/2vYnYzH



Teach your kids woodworking skills with these well-chosen projects: a wizard wand, a sanding block, a charging station, and a sturdy box with a hidden compartment.

ELECTRICITY FOR YOUNG MAKERS

Author: Marc de Vinck
Publisher: O'Reilly
Price: £10.50
ISBN: 978-1680452860
magpi.cc/2vYxGlP



A small collection of projects using easy-to-obtain items that combine fun, education, and a reasonably good chance of success – even for young children with non-techy parents.

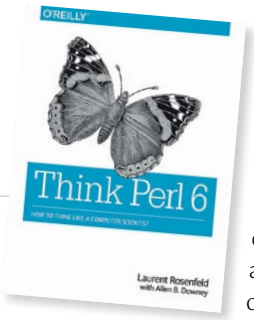
MAKE: PAPER INVENTIONS

Author: Kathy Ceceri
Publisher: O'Reilly
Price: £15.99
ISBN: 978-1457187520
magpi.cc/2vYomhI

Paper, switches, sensors. Wearables from foldables. Edibles. Generators and geodesics. Space rovers and sun spirals. Craft meets maths, and next time you're looking to occupy bored kids, you'll bless Ceceri's fertile mind.

THINK PERL 6

Authors: Laurent Rosenfeld, Allen Downey
Publisher: O'Reilly
Price: £47.99
ISBN: 978-1491980552
magpi.cc/2vYO6KH



Think Perl6 is aimed not so much at teaching Perl 6, but at teaching programming (to 'Think Like a Computer Scientist'). Early-stage Python programmers will benefit from seeing what they've learnt re-examined in another language, and with Perl 6's ability to work with modules written in Python (and other languages), Perl 6 may prove to be a good second language.

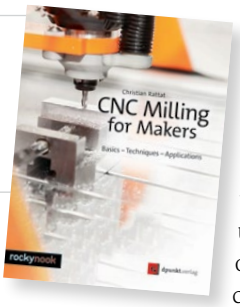
The learning is split into two sections – the first eleven chapters covering the basics that any programmer needs to know: variables, expressions, statements, functions, conditionals, recursion, operator precedence, loops, basic data structures, and algorithms. The second half covers more advanced techniques and paradigms that are still essential, but perhaps not needed day-to-day.

A great introductory chapter covers topics like debugging, abstraction, and types. As we move on to the assignment of variables, Rosenfeld does a grand job of beginning to peel back the layers and starting to glimpse the reasons for language decisions, such as why variables must be declared. It is this sort of detail that also makes it a good book on Perl 6 for those who can already program in another language. There are also more than a thousand code examples, and good exercises rounding off each chapter.

Score ★★★★★

CNC MILLING FOR MAKERS

Author: Christian Rattat
Publisher: Rocky Nook
Price: £22.50
ISBN: 978-1681983028
magpi.cc/2vYQNvI



Admit it: the thought of owning your own milling machine is very tempting. Perhaps you read the feature on Mark Buttle's Pi-controlled CNC machine in *The MagPi* issue 39. The cost can certainly be spread by clubbing together and buying one for use at your local makerspace. The time involved in building one from scratch is not insignificant, and there's a level of knowledge and access to tools that not all spaces will have. Given that, building from a kit could be much more viable, and Christian Rattat's book tackles this latter case.

More specifically, Rattat tackles putting together the components of a Stepcraft-2/600 which, with a work area roughly the size of an A2 sheet of paper, and a range of attachments, is pretty popular. Readers considering a self-build, or purchasing another design, will still find plenty of useful and detailed material on general CNC machine construction, design, and use.

Where this work loses utility is the lack of Linux-specific advice: Rattat only talks about proprietary software, and Stepcraft's default USB microcontroller offloads the real-time control from the operating system. Discussion of the possible adaptations to use LinuxCNC would have been extremely useful here.

Score ★★★☆☆

OURS TO HACK AND TO OWN

Editors: Trebor Scholtz, Nathan Schneider
Publisher: OR Books
Price: £14
ISBN: 978-1682190623
magpi.cc/2vYdzUx

OURS
TO HACK
AND TO OWN
THE RISE OF PLATFORM COOPERATIVISM, A NEW VISION FOR THE FUTURE OF WORK AND A FAIRER INTERNET
EDITED BY TREBOR SCHOLZ AND NATHAN SCHNEIDER

A 'guidebook for a fairer kind of internet' that looks at emerging platforms from a cooperative standpoint. As Pi users work on building the Internet of Things, many are working to build the platforms for working together, and the infrastructure for connected devices, such as LoRaWAN networks across cities. This is the open-source way.

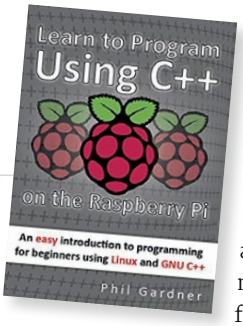
The Silicon Valley way, by contrast, is investment driven, and needs to take control of the services used – cloud infrastructure, learning platforms, or online marketplaces – and 'extract value'. *Ours to Hack and to Own* is a wonderfully diverse collection of short essays, offering alternative visions for cooperation, but backed by numerous practical examples of cooperativism in action, such as the Fairmondo online marketplace, and various funding platforms.

The writers are often politically driven, and it would be impossible to agree with all of them, but few essays fail to raise interesting points for consideration. And consider them we must, as the kind of internet to which we connect our hardware projects and startup ideas is far from settled, and will depend on the voices and efforts of everyone who wants an open platform on which to build.

Score ★★★★☆

LEARN TO PROGRAM USING C++ ON THE RASPBERRY PI

Author: Phil Gardner
Publisher: Zero-Index
Price: £15.95
ISBN: 978-0995791800
magpi.cc/2vYR8yu


Learn to Program
Using C++
on the Raspberry Pi
An easy introduction to programming for beginners using Linux and GNU C++
Phil Gardner

C++, like Java, does not make a good first language – at least that's the received wisdom. The Pi encourages Python and Scratch as beginner languages, but it also comes with a complete environment for compiling programs written in C and C++, and both of these languages feature extensively in embedded development. If building fun bits of hardware with small boards is what has attracted you to the Pi, then why not dive straight in to C++?

Given the use of C-family languages in some GCSE and A-level curricula, there is another audience for a beginner-friendly guide. Long-time coder and teacher Phil Gardner gives us an example-rich, step-by-step guide, written at a level for just such new programmers.

It's a large-format book, which makes for clearly legible screenshots and code samples. All the essentials of C++ are covered in an equally matter-of-fact manner, from conditionals and loops, through arrays and functions, to structs and pointers. Much time is devoted early on to dealing with errors, as this is the aspect of programming most frustrating to the newcomer. Little is Pi-specific, beyond the ready-rolled compiler environment, but this is an excellent introductory text.

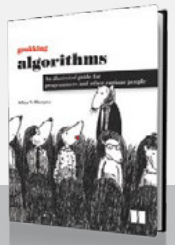
Score ★★★★☆

ESSENTIAL READING: INTELLIGENT PYTHON

We live in golden times, with everything from essential algorithms to machine learning accessible in Python.

Grokking Algorithms

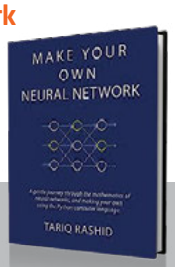
Author: Aditya Bhargava
Publisher: Manning
Price: £27.99
ISBN: 978-1617292231
magpi.cc/2vYBgMw



A wonderfully visual guide to the algorithms most programmers need, backed up with simple Python snippets.

Make Your Own Neural Network

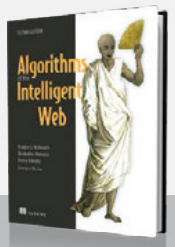
Author: Tariq Rashid
Publisher: CreateSpace
Price: £35.00
ISBN: 978-1530826605
magpi.cc/2vYNyEF



Rashid gives you a layman's guide to neural nets (some maths involved), then clear step-by-step Jupyter and Pi implementations.

Algorithms of the Intelligent Web

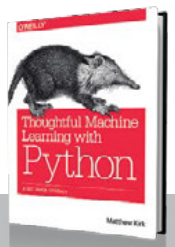
Authors: Douglas McIlwraith, Haralambos Marmanis, Dmitry Babenko
Publisher: Manning
Price: £27.99
ISBN: 978-1617292583
magpi.cc/2vZc9cA



ML for web data with Python's scikit-learn, in an algorithmic guide to real-world data science problems.

Thoughtful Machine Learning with Python

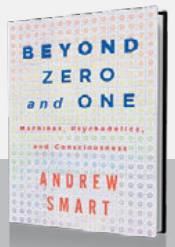
Author: Matthew Kirk
Publisher: O'Reilly
Price: £34.50
ISBN: 978-1491924136
magpi.cc/2vY3VS4



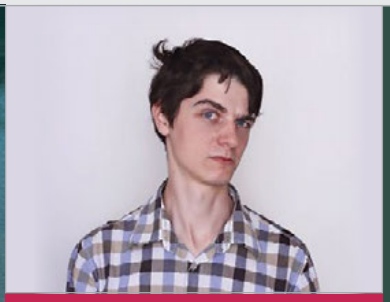
A terser ML guide, with more maths and Python, but still a fun and rewarding read.

Beyond Zero and One: Machines, Psychedelics, and Consciousness

Author: Andrew Smart
Publisher: OR Books
Price: £14.40
ISBN: 978-1682190067
magpi.cc/2vYAPSv



AI is missing the point, unless robots can learn to hallucinate like humans. A fascinating and convincingly argued look at consciousness.



Szymon Dzwonczyk

Occupation: CEO, Kell Ideas Ltd

TURTLE ROVER INTERVIEW

We talk to the Mars Rover prototype engineers behind the new Kickstarter rover, powered by Raspberry Pi

Created by the Mars Rover prototype engineers at Wroclaw University of Technology, Poland, the Turtle is a robust, waterproof rover that can be used to explore hidden worlds too small or dangerous for humans.

Can you tell us about the Turtle Rover?

Turtle is an open-source mobile robot designed to take every maker payload in a new environment.

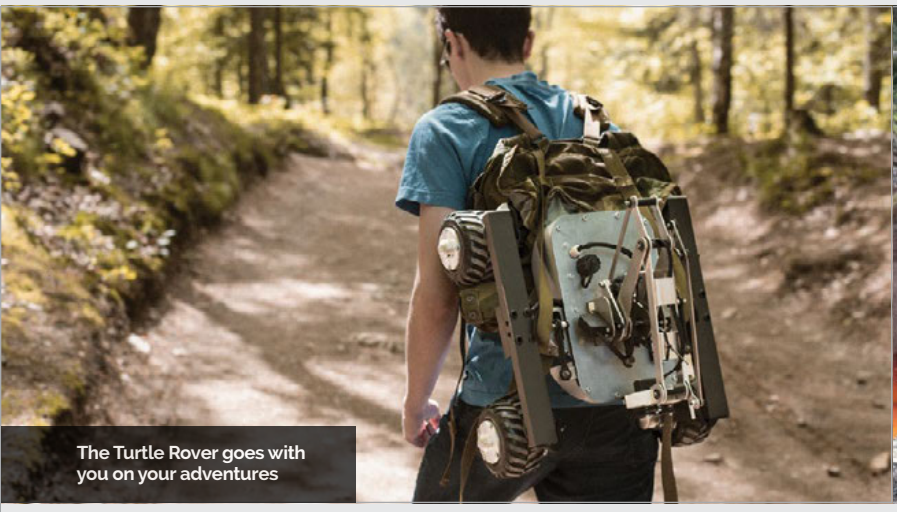
The rover is equipped with a full HD camera, watertight case, and a robotic arm. As it's built around a Raspberry Pi with Raspbian on board, you can control it up to 200 m away by WiFi with any web-enabled device (such as tablet, laptop or phone).

Turtle can be used as a land drone for cave and urban exploration, as a development platform for navigation and autonomy algorithms, and even for business, as a robot carrying special 3D-scanning or inspection equipment.

Who is on the team?

We are a team of five who met at Wroclaw University of Technology in Poland. Julia is a creative director and a graphic designer. She was responsible for the rover interface – essentially everything the operator can see. Justyna is our PR and marketing manager, showing the world every detail of our work. Aleksander is the mechanical designer of the robotic arm and other external equipment. Marcin is our software and electronics engineer, and made everything to bring life to the rover. I am the team head and chief mechanical

It's easy to control from any internet-connected device



The Turtle Rover goes with you on your adventures

engineer. I built not only the Turtle chassis, but the team as well.

How did the idea come about?
We've been involved in Mars rover prototype development since 2015 at Wroclaw University of Technology. Then part of our team worked on equipment for the joint ESA/DLR/SSC BEXUS 21 mission that took our environmental study experiment up to the stratosphere. After working for science, we decided to establish our own company and use our experience to design a 'Mars rover' for everyday users. From the start, it was supposed to be extremely sturdy yet affordable, to show everyone that robotics doesn't need to be expensive to be useful.

Why the Raspberry Pi?
We used the Pi in the university Mars rover design as well, and Turtle is designed to fit a Raspberry Pi 3. We are not only looking for hardware when designing the robots – the community is what interests us the most. The rover itself provides infinite possibilities, but it's the people who need to tell you how to write image processing code or give the rover the brain to drive by itself. It's a lot easier to talk to someone else when working on a project rather than keeping everything to yourself.

As a team, we always loved the idea of an affordable mini-computer to fit into our work, and here we are.

How waterproof is it? Can you explore underwater with it?
The rover is watertight, which essentially means it can be submerged underwater, up to three metres deep. Every motor is sealed using rubber components, and both the boards and the battery are enclosed inside watertight cases. What's more, there's even a special compartment to be utilised by the user. You can add your own electronics to the rover and still keep it watertight.

The only thing with underwater use is to remember to keep the antenna above the water line. Almost every wireless signal cannot go through water. Using the rover's modular design, you can adapt one of its cases to act as a buoy to keep the antenna up – we plan to cover it in our blog.

How long have you been working on it?
With a five-year know-how covering similar mobile robots, we started to work on Turtle at the beginning of June 2016. It was a year-round struggle to keep the rover functional, and to be able to produce it using mostly our internal resources. We don't outsource the assembly, and we produce most of the components using 3D printing, CNC machining, and laser cutting. This is why we are so eager to get as much feedback from both our customers and open-source DIY builders as possible. As the production is super-elastic, we can provide swift modifications to the design to fit everyone's needs.

Above The rover can explore awesome places with you

Turtle Rover is watertight, so it can go almost anywhere

GET INVOLVED!

The Turtle Rover's Kickstarter campaign ended a few days after we went to print, but that doesn't mean you've missed out! The Turtle Rover is completely open-source, including the files for the 3D-printed chassis. You can print, build, and code one yourself, or buy a kit or an assembled robot from **turtlerover.com**.

THE MONTH IN RASPBERRY PI

Everything else that happened this month in the world of Raspberry Pi

THE COMMUNITY'S WEEKEND PROJECTS

Need more inspiration for your weekend projects? Check out some of these cool projects from our readers

Monday is not everyone's favourite day of the week. However, we like to try to add a little fun to your morning with our weekend project roundup on Twitter. Loads of readers send us the stuff they've been working on over the weekend, and we love to see it all! Here are some of our favourites.

FRED-209

A custom Nerf-firing robo-tank that gives you only 20 seconds to comply. We got a bit of a preview of this last month, and we've been excited to see the final product. Learn more about it (and see it in action!) here: **magpi.cc/2xdabaQ**.

OutRun Tomy toy conversion

While we've seen many console and arcade hacks over the past few years, this inventive hack of one of those sports car dashboard kids' toys wowed us when we saw it. It doesn't hurt that it's themed around OutRun, one of the best arcade series of all time. Find out more here: **magpi.cc/2xckwUo**.

Hologram

A nice, simple project using an engraved acrylic sheet and an LED strip. Brian Corteil has managed to make a very lovely hologram-effect light, and we want one on our desk.

Steering wheel

Not just a simple steering wheel – this project is a custom controller for American Truck Simulator. Spencer Organ has been making lots of different custom pieces for his own special control setup.

EMERGENCY TRANSMISSION:

PIONEERS
AUTUMN 2017 CHALLENGE

It's a calamity of epic proportions, and only you can save us! Time to get your thinking hats on, as you use tech to #MakeYourIdeas and save us all!

We've received an alarming video message – you can watch it at **rpf.io/pioneers**. We don't know this young woman's name or exactly what has happened, but we must help her! If things are as bad as she says they are, our only hope of survival is to work together.

Steps to saving the world

Bring together a TEAM of up to five awesome thinkers and makers between the ages of 11 and 16, based in the UK or the Republic of Ireland, together with a mentor aged 18 or over.

REGISTER your team at rpf.io/pioneers.

Brainstorm something to help avert the crisis using TECH, and then #MakeYourIdeas by Friday 1 December – or else it will be too late.

Get cool stuff, WIN prizes, and save the world!

Your team needs to build something to help this survivor in the treacherous situation she's in. What you decide to make is completely up to you – it could be something to help you reach her location, something to help monitor supplies, a way to warn of approaching danger, or anything else you think would help.

Any tech will do. This is an emergency, so you'll need to think creatively with anything you can get your hands on: laptops, cameras, microcontrollers, Raspberry Pis – anything at all. You can't afford to be choosy, so you'll have to be resourceful with whatever digital tech you have access to.

You need to make sure you record your working process. Take photos and footage to document how you build your make, and put together a video to present your work when you're done making. That way, even if things don't work out quite as you'd hope, you'll still be able to show the work you put in – and we'll still want to see it. Even the wonkiest prototype can be a step on the road to the tech that saves the world from disaster.

If you're not quite ready to take part in this Pioneers challenge, head over to rpf.io/pioneers and click 'Get involved' to register your interest in future digital making challenges.

SURVIVAL PROJECTS

Map out the zombies in the area. Stay safe!
magpi.cc/2y9MCiq

Distract zombies by creating classic literature
magpi.cc/2y9grQ3

Create an app for your phone to avoid the zombies you mapped
magpi.cc/2y9xdOP

HELP RASPBERRY PI CELEBRATE ITS BIRTHDAY!

The Raspberry Pi Foundation wants to put on a global celebration for its sixth birthday – here's how you can help!

For the last few years, we have held a big Raspberry Pi community event in Cambridge around Raspberry Pi's birthday, where people have come together for a huge party with talks, workshops, and more. We want more people to have the chance to join in with our birthday celebrations next year, so we're going to be coordinating Raspberry Jams all over the world to take place over the Raspberry Jam Big Birthday Weekend, 3–4 March 2018.

Big birthday fun

Whether you've run a Raspberry Jam before, or you'd like to start a new Jam in your area, we invite you to join us for our Big Birthday Weekend, wherever you are in the world. This event will be a community-led, synchronised, global mega-Jam in celebration of our sixth birthday and the digital making community! Members of the Raspberry Pi Foundation team will be attending Jams far and wide to celebrate with you during the weekend.

Jams across the world will receive a special digital pack, and we'll also be sending out party kits to registered Jams.

RASPBERRY JAM

Get involved

If you're keen to start a new Jam, there's no need to wait until March – why not get up and running now? Then you'll be an expert by the time the Raspberry Jam Big Birthday Weekend comes around. Visit **rpf.io/jam** for more information, and submit your event to the map when you're ready.

Once your Jam is up and running, register it for the birthday party: **rpf.io/bdayjamform**.

If you don't fancy organising a Jam for our Big Birthday Weekend, but would like to celebrate with us, keep an eye on our website for an update early next year. We'll publish a full list of Jams participating in the festivities so you can find one near you.

NEED HELP STARTING A JAM?

First of all, check out the Raspberry Jam page to read all about Jams, and take a look at our recent blog post explaining the support that we offer: **rpf.io/jam**.

If there's no Jam near you yet, the Raspberry Jam Big Birthday Weekend is the perfect opportunity to start one yourself! If you'd like some help getting your Jam off the ground, we've produced a free Raspberry Jam Guidebook full of advice gathered from the amazing people who run Jams in the UK. Download it from **magpi.cc/2q9DHfQ**.

If you have more queries, email **jam@raspberrypi.org**.

KICKSTART THIS!

Raspberry Pi projects you can crowdfund this month

AUTOPI

kck.st/2wqOTGe

"What if your car had eyes?" the AutoPi Kickstarter video asks. It's a car computer powered by Raspberry Pi that offers many enhancements over some of the standard tech you find in modern cars. This includes monitoring of your car's performance that you can check online at any time, customisable if-this-then-that events, and dash cams.

NOTAGRAMA

kck.st/2wnR3F1

A pretty cool product that uses machine vision and a Pi to read sheet music. You can lay out music using chips or cards of specific notes on the provided sheet, and it will read and play the music. It looks like a fun way to learn how sheet music works and experiment with how melodies come together.

BEST OF THE REST

Here are some other great things we saw this month

PEDAL-PI

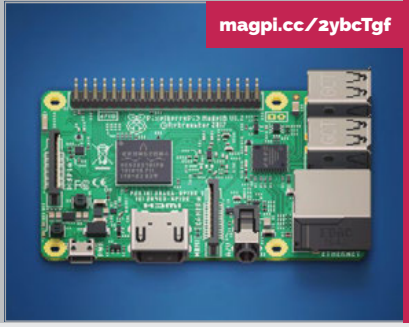
magpi.cc/2yaVwvN

This is cool: a Pi-Zero-powered guitar effects pedal that can be programmed to create different effects and sounds when you press it. It uses an extra board to handle the inputs, but a lot of processing is done on the Pi itself.

PIXELBERRY PI

magpi.cc/2ybcTgf

Not a physical project, but a wonderful pixel-art version of the Raspberry Pi by Retronator! When we first saw it in a Twitter thumbnail we thought it was a photo, which goes to show the quality of this work.



magpi.cc/2yaXOvg

AUTOMATED NERF SENTRY GUN

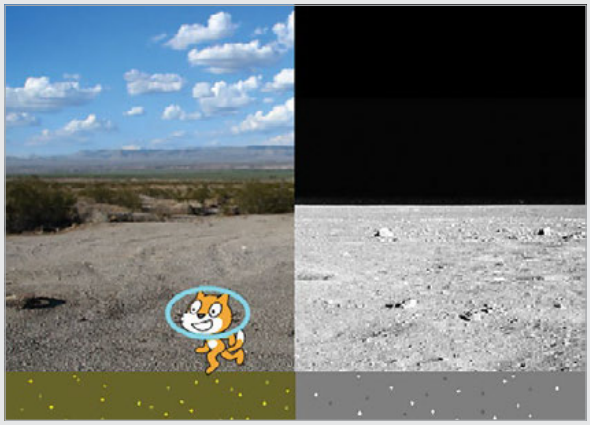
Nerf turrets are fun, but this one goes a step further by adding facial recognition. It's powered by IoT platform n.io, and uses a Pi and laptop to look for targets by detecting faces. When a target is found, the Pi points the gun to aim at the target's body. It looks to have a beefy dart capacity, so unless you're Wonder Woman in no-man's-land, you'd best stay out of its view.

MOONHACK 2017:

A NEW WORLD RECORD!

Kelly Tagalan from Code Club Australia explains how kids around the world hacked the moon to set a new world record

On 15 August 2017, Code Clubs around the globe set a world record for the largest number of kids coding in a day! From Madrid to Manila and from Sydney to Seoul, kids in Code Clubs, homes, and community centres around the world used code in order to 'hack the moon'.



Below Children coded a special moon-themed project using Scratch, Scratch Jr, or Python

The Moonhack movement

The first Moonhack took place in Sydney in 2016, where Code Club set a record of 10 207 kids coding in a day.

The response to Moonhack – not just in Australia but around the world – blew the team away, and this year they decided to make the challenge as global as possible.

"I want to create anything that can benefit the life of one person, hundreds of people, or maybe even thousands," said one Code Club Moonhack participant in Australia.

Preparation for the event required a lot of teamwork and collaboration within the global Code Club family. The Code Club New Zealand team helped to create and execute new projects with help from Code Club in the UK, while Code Club Canada, France, South Korea, Bangladesh, and Croatia all created translated materials to allow even more kids to take part.

Moonhack 2017

From the moment the clock struck midnight in New Zealand, children had 24 hours to try coding a specially made Moonhack project using Python, Scratch, or Scratch Jr. Creative Moonhackers were encouraged to make their own custom projects, and there were amazing submissions on a range of themes – from moon football to heroic dogs saving our natural satellite from alien invaders!

Moonhack 2017

Date: 15 August 2017
Location: Worldwide

Left Children from 56 countries took part in the event

The top five Moonhack countries submitting projects were Australia, New Zealand, the USA, the UK, and Croatia, but there were contributions from so many more amazing places, including Syria and Guatemala. The event was a truly international Code Club collaboration!

Global Moonhacking

The founder of Code Club Bangladesh, Shajan Miah, summed up the spirit of the day well: "Moonhack was a great opportunity for children in Bangladesh to take part in a global event. It connected the children with like-minded people across the world, and this motivated them to want to continue learning coding and programming. They really enjoyed the challenge!"

> "Kids had fun taking part, and experienced what it feels like to create with code"

In the end, 28575 kids from 56 countries and 600 Code Clubs took part in Moonhack to set a new record. Record Setter founder and Senior Adjudicator, Corey Henderson, travelled to Moonhack Mission Control in Sydney to verify the record, and we were thrilled to hear that we came close to tripling the number of kids who took part last year!

Of course, the most important thing about Moonhack was that the kids had fun taking part, and experienced what it feels like to create with code. One astute nine-year-old said: "What I love about coding is that you can create your own games. Coding is becoming more important in the work environment and I want to understand it and write it."

This is why we Moonhack: to get kids excited about coding, and to bring them into the global Code Club community. We hope that every Moonhacker who isn't yet part of a Code Club will decide to join one soon, and that their experience will help guide them towards a future involving digital making. Here's to Moonhack 2018!

Kids got to work coding at Moonhack HQ

FIND OUT MORE

If you would like to be part of Moonhack 2018, make sure you sign up at **moonhack.com** for alerts and news.

If you're interested in volunteering at a Code Club, head to **codeclubworld.org** to find out more. There, you'll find information on starting a new club anywhere in the world.

COMMUNITY PROFILE

CAT LAMIN

Certified Educator, Jam Maker, Teacher, Outreach Champion and much, much more...

Cat Lamin

Category: Raspberry Pi Certified Educator

Day job: Education outreach

Website: twitter.com/CatLamin
catlamin.com

From coding clubs to educational events, pi-top outreach and more, Cat Lamin has become a regular face within the Raspberry Pi community – and for good reason.

Into the classroom

With a BA in English from the University of Birmingham, there was no question as to the profession Cat saw herself working in. "I've known I wanted to be a primary school teacher since I was about nine," she admits, going on to explain how her A-level choices in Maths, Further Maths and English helped to keep her on track, completing her education with a PGCE at the University of Plymouth.

Cat went on to start teaching, with her speciality in Maths, and soon found herself lifted to the role of Head of ICT. "One of the children at my school told his mum that 'Miss Lamin makes being geeky cool', which was kinda cool," she reveals.

Moving on from teaching, although she still dedicates a few hours every fortnight to a local school, Cat now works in the computer science community, offering her services across a multitude of platforms and events. "I get to teach in a school local to me for an afternoon every other week, so I've just been teaching Year 6 about interactive fiction, and can't wait to bring in some Raspberry Pis for them to play with."

Below Ever the avid 'geek girl', Cat also dedicates time to hacking and digital making

From the age of nine, Cat has wanted to be an educator. Through classes, educational talks, and coding events, she's reached more than the average classroom

Championing education

Above As part of her role with pi-top, Cat was recently sent to Argentina to talk to the Ministry of Education

For pi-top, creators of Raspberry Pi-based learning tools, Cat works as an Education Outreach Champion, running workshops and helping to grow the user community. Through pi-top she's attended educational shows such as Bett, given talks at the Raspberry Pi Birthday Bash, and presented to the Argentinian Ministry of Education. "The other thing I do at pi-top is talk to the developers about their ideas for software, to try and help them make it classroom-friendly," Cat explains. She then works to put developers in touch with teachers who may be able to offer help and advice.

Outside pi-top, Cat also dedicates her time to being an active member of the Raspberry Pi community. As a Picademy alumnus, she's facilitated two further Picademy teacher training events, with her third due later this year. And if that's not enough, she's continued to add to her role by running Coding Evenings for teachers, offering a relaxed introduction into the world of computer science, and co-hosting Wimbledon Jam with Albert Hickey. "Occasionally," she adds, "I've been known to organise something called a #geekeat, which is just a meal in central London or in Cambridge where anyone who is part of the Raspberry Pi community can meet up with no pressure to do anything other than talk and have fun." So when we say Cat is active within the community, we mean it.

> "She's continued to add to her role by running Coding Evenings for teachers"

Cat will be attending PyCon later this year to give a talk on mental health, a subject she feels strongly about, and hopes to help raise awareness for developers who suffer in silence. And moving on, she'll be joining fellow Picademy alumnus and Raspberry Pi Foundation Member Sway Grantham in delivering advanced Scratch training at the National STEM Centre in December.

HIGHLIGHTS

magpi.cc/2xbzGsZ

PICADEMY

As well as being a Raspberry Pi Certified Educator (RCE), Cat has helped to facilitate a few Picademy events, with her third happening this October in Cardiff. Cat is one of the many RCEs to agree that Picademy has had a massive impact on her life.

magpi.cc/2xc2tO8

MAPLE BEAR CANADIAN SCHOOLS

Having previously provided training aids for the organisation, Cat was asked to visit Brazil for two weeks this year to train teachers in computational thinking at Maple Bear Canadian Schools in São Paulo, Belo Horizonte, and João Pessoa.

FEATURED THIS ISSUE

LINDA LIUKAS
PROGRAMMER, STORYTELLER AND ILLUSTRATOR

ALAN O'DONOHOE
CAS MASTER TEACHER AND LEADER OF EXA.FOUNDATION

CAT LAMIN
RASPBERRY PI CERTIFIED EDUCATOR AND CAS MASTER TEACHER

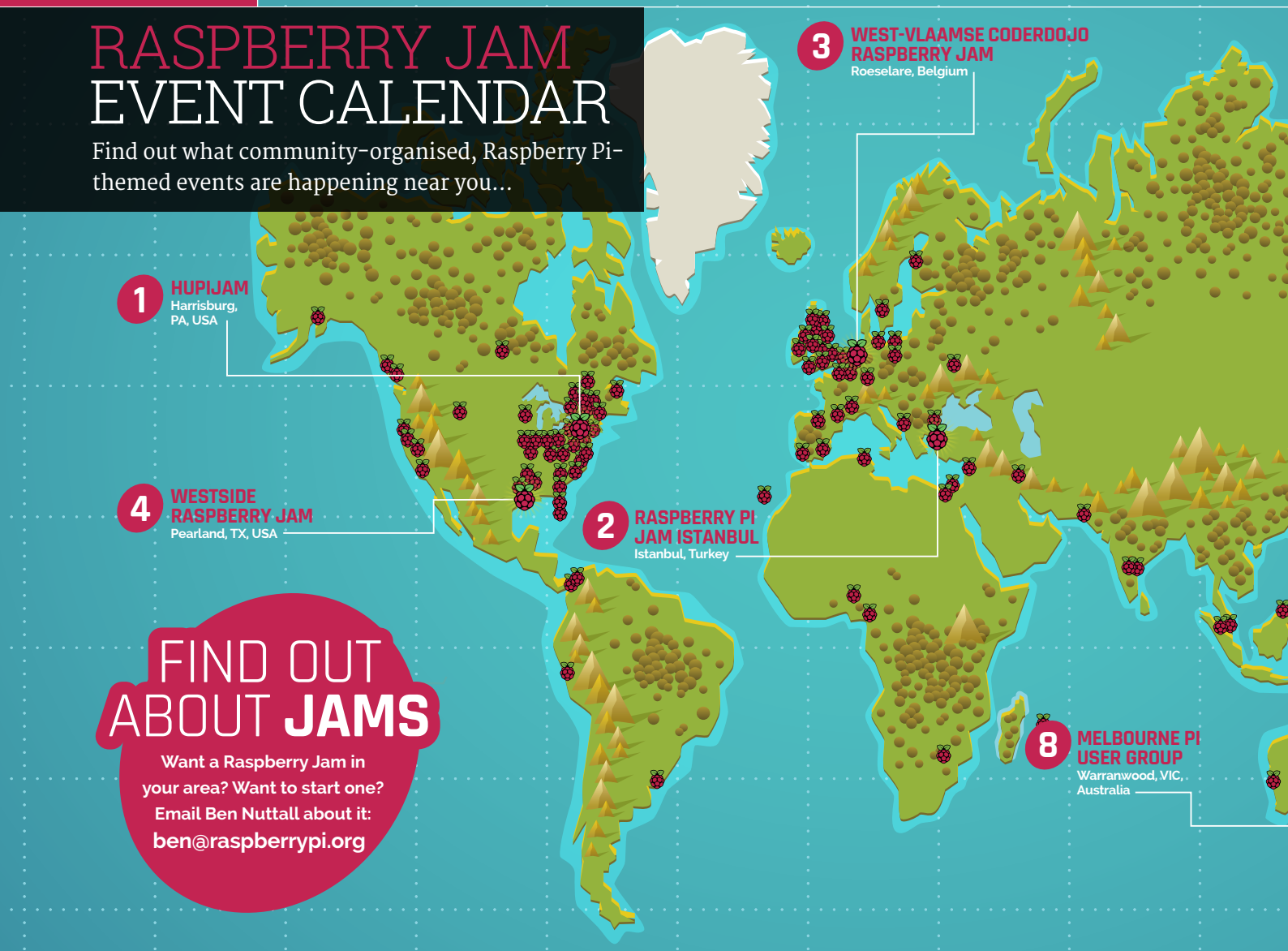
helloworld.cc

HELLO WORLD

You'll find Cat listed as a Featured Contributor in this term's Hello World magazine. While discussing teaching coding to non-English-speaking students, she offers her own solutions to the issues faced by educators.

RASPBERRY JAM EVENT CALENDAR

Find out what community-organised, Raspberry Pi-themed events are happening near you...



FIND OUT ABOUT **JAMS**

Want a Raspberry Jam in your area? Want to start one? Email Ben Nuttall about it:
ben@raspberrypi.org

HIGHLIGHTED EVENTS

1 HUPIJAM

When: Saturday 7 October
Where: Harrisburg University, Harrisburg, PA, USA
magpi.cc/2y7ghIW
A welcoming event where you'll meet and learn from like-minded people in a friendly environment.

2 RASPBERRY PI JAM ISTANBUL

When: Saturday 7 October
Where: Büyük Milas Han, Istanbul, Turkey
magpi.cc/2y7DElM
A Raspberry Jam for those in and around Istanbul, which hopes to become a regular event.

3 WEST-VLAAMSE CODERDOJO RASPBERRY JAM

When: Saturday 21 October
Where: ARhus, Roeselare, Belgium
magpi.cc/2x8pKAh
Together with CoderDojo, ARhus is organising the very first West-Vlaamse Raspberry Jam in Roeselare.

4 WESTSIDE RASPBERRY JAM

When: Tuesday 24 October
Where: Pearland Westside Library, Pearland, TX, USA
magpi.cc/2x9C9nH
Come and show off your Pi creations and learn each month about a different component you can use on the Pi.

REGULAR EVENTS

5 RASPBERRY JAM @ PI TOWERS

When: Saturday 7 October
Where: Raspberry Pi HQ, Cambridge, UK
magpi.cc/2x8pWzB
A family-friendly event where all are welcome, providing coding and digital making activities for children and adults.

6 CORNWALL TECH JAM

When: Saturday 14 October
Where: Bodmin Library, Bodmin, UK
cornwalltechjam.uk
For anyone interested in technology, of all ages and abilities. Ask questions and learn about programming.

WE'VE HIGHLIGHTED SOME OF THE AREAS IN NEED OF A JAM!
CAN YOU HELP OUT?
5 RASPBERRY JAM @ PI TOWERS
Cambridge, UK
7 16TH EGHAM RASPBERRY JAM
Staines-upon-Thames, UK
6 CORNWALL TECH JAM
Bodmin, UK

7 16TH EGHAM RASPBERRY JAM

When: Sunday 15 October
Where: The Glanty, Staines-upon-Thames, UK
magpi.cc/2x8qXaT
This month is Halloween themed, so come along and make some spooktacular Pi projects!

8 MELBOURNE PI USER GROUP

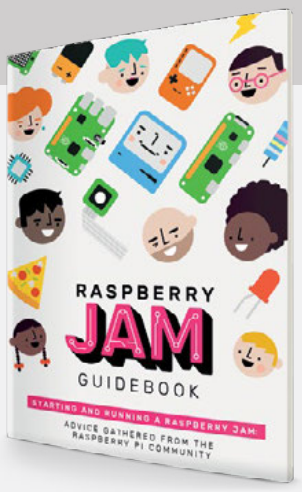
When: Tuesday 17 October
Where: Melbourne Rudolf Steiner School, Warranwood, VIC, Australia
mpug.clarkson.id.au
The group's aim is to bring like-minded people together to talk about how they're using the Raspberry Pi.

RASPBERRY JAM ADVICE

SAFETY

> "Our venue, a university, required us to perform a risk assessment and have public liability insurance. I had experience with risk assessments from work, so that was straightforward, but anyone who doesn't have that experience can find plenty of examples online."
>
> **Andrew Oakley**
> Cotswold Jam

Every Raspberry Jam is entitled to apply for a Jam starter kit, which includes magazines, printed worksheets, stickers, flyers and more. Download the Raspberry Jam Guidebook at **magpi.cc/2q9DHfQ**.

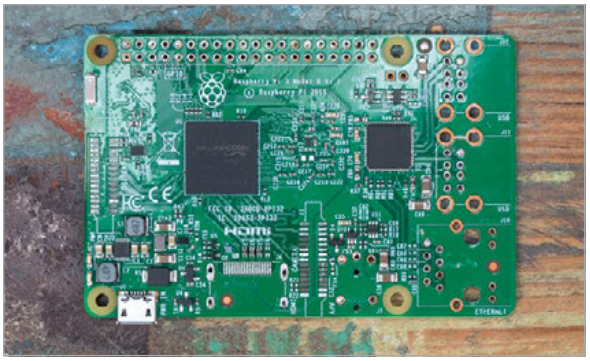


YOUR LETTERS

See my project

I have a fun Raspberry Pi project that I've made! How do I go about showing it to you? Will I be able to put it in the magazine?
Alex D

We love seeing what you've made with the Raspberry Pi! Send us your projects via email (**magpi@raspberrypi.org**) or on Twitter (**@TheMagPi**). As for getting it into the magazine, it largely depends on what you send us, but there are many ways for us to feature cool projects in *The MagPi*.



Above The world's thinnest Raspberry Pi 3. Image credit: Pimoroni

x86 Stretch

I upgraded my Raspberry Pi to the new version of Raspbian Stretch and really liked it. I've managed to misplace the disc with the PC version of the Raspberry Pi Desktop, and I was wondering if the version on there used Stretch or if it was still Jessie?

Either way, is there a place I can go to download the ISO, as I've misplaced the disc? Thanks.
Sarah

The version of the Raspberry Pi Desktop for x86 PCs that came with issue 60 was based on Debian Jessie rather than Stretch, and has not been updated since the release of Raspberry Pi Desktop on Raspbian Stretch. We can point you to the ISO, as it's available now on the Raspberry Pi OS download page at **rpf.io/x86**.

If you need a guide to installing it on your PC, we have a new instructional video on how to do this, which you can find at **magpi.cc/2xbvyJG**.

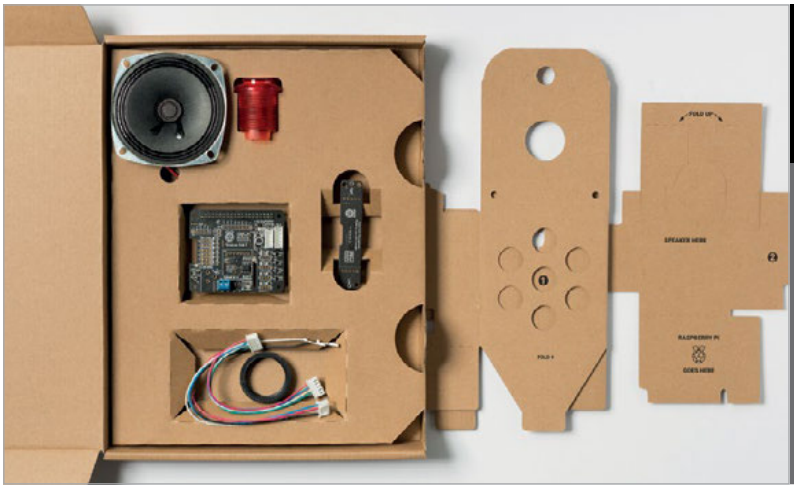
A minimalist Raspberry Pi

I'm aware you're not able to get a kit to build a Raspberry Pi; however, it would be quite useful for me right now! I'd like to have something as powerful as the Raspberry Pi 3 and as slim as the Pi Zero, or even slimmer.

I was thinking about the Compute Module 3, but I was wondering if there was a way to get a bare Raspberry Pi 3 board? Is it safe to take apart a commercial Raspberry Pi 3? I have a couple of spare ones laying around.
Derek

Great timing with this question! Pimoroni has just released a video on how to slim down a Raspberry Pi 3 by desoldering all the ports and pins except the micro USB power port. You can find more information here: **magpi.cc/2xco4WD**.

As for buying one, we don't know of anywhere that will sell you a plain board, so your best bet is to follow Pimoroni's instructions with one of your spare Raspberry Pi 3s!



GETTING THE AIY PROJECTS VOICE KIT

We're still getting emails from a lot of people asking how they can get their hands on issue 57 or the AIY Projects Voice Kit that came with it. Well, the good news is that Voice Kit is now available as a standalone product! The Pi Hut is taking pre-orders for the kit in the UK, and Micro Center in the US. Other retailers will also be stocking it. See page 10 of this month's News section for more details.

FROM THE FORUM: PRINTED ESSENTIALS

The Raspberry Pi Forum is a hotbed of conversations and problem-solving for the community.
Join in via **raspberrypi.org/forums**

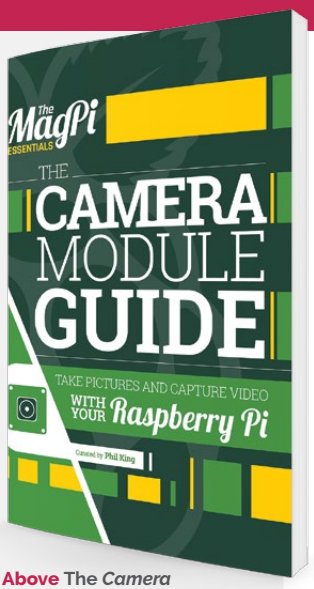
WRITE TO US

Have you got something you'd like to say?
Get in touch via **magpi@raspberrypi.org** or on The MagPi section of the forum at: **raspberrypi.org/forums**

Hi, does anyone know when the Camera Module Essentials book is due out as a printed version?
Andrew

As we've done in the past, once we've completed a new series of Essentials books, we'll do a print run and they'll be available in our store, and from Amazon and other suppliers. We can't say yet when that will be, as even we don't know quite yet. We can assure you they're coming, though.

If you can't wait until then, you can always print out a copy of the *Camera Module Guide* using the PDF. As it's licensed under Creative Commons, we let you do that – you could even go to a proper printer and get a nice glossy version for yourself! Grab the PDF from here: **magpi.cc/2ufdjnT**.



Above The *Camera Module Guide* covers everything you need to know to get started with the Camera Module

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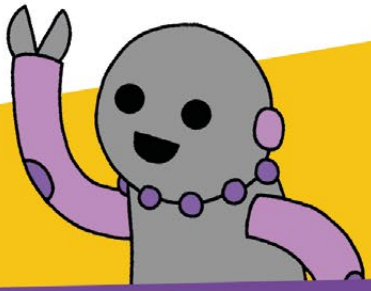
{code club}



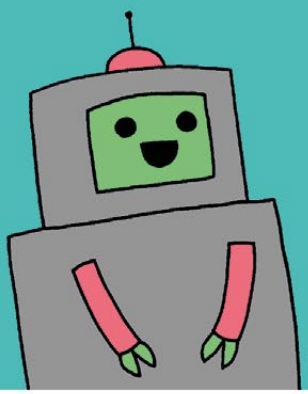
START A CODE CLUB IN YOUR SCHOOL!

Code Club is a network of volunteers and educators who run free coding clubs for young people aged 9-13.

Our aim is to inspire the next generation to get excited about computer science and digital making.

"We use Code Club's fun educational resources to run a weekly after-school club for Year 7 and Year 8 pupils. The students benefit considerably from the extra challenge!"

Karen Dadd, Computing Teacher



- **Code Club is free**
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MATT RICHARDSON

Matt Richardson is the Executive Director of the Raspberry Pi Foundation North America and author of *Getting Started with Raspberry Pi*. Contact him on Twitter **@MattRichardson**.

CREATING TO LEARN

In **Matt Richardson's** experience, creating projects leads to the most efficient learning

I was a graduate school student in New York City in 2012 when the extremely destructive hurricane Sandy made landfall on the North Atlantic coast of the United States. Our student email group was especially active at that time. Classes were cancelled and students were checking in as safe, reporting problems, and helping each other out. The email threads told a story about what was going on at the time, and so I wanted to capture and present that story outside the context of email. I wanted to take the story told by the emails and put it into my own single-edition physical book.

Python project

To accomplish that, I spent a full weekend figuring out how to get Python to read emails from my account, process them, and create a PDF to send to the printer for publishing. It started off as a simple enough idea, but the complexity began to reveal itself as I worked on the project. How do I number the pages? How do I split up the chapters? How do I create a table of contents? How do I solve the problem of odd characters in the emails that were wreaking havoc with my Python script?

During that weekend of figuring out how to turn email messages into a printed book, I probably learned more about Python than I have at any other time in my life.

Creative learning

Just a few days ago I was reminded of this experience when I came across a great piece of advice on Twitter from Seattle-based data scientist Jake VanderPlas (**@jakevdp**). He tweeted, "My advice on learning Python: Don't set out to 'learn Python'. Choose a problem you're interested in and learn to solve it with Python."

Jake's tweet perfectly sums up what I learnt first-hand while toiling away to create a physical volume of hundreds of email messages. Having a particular project in mind when you use any technology (and not just Python) is the best way to learn it. Creating something new provides a clear objective, and you get more out than you put into it. You bring something new into the world, and you learn a lot along the way.

Real objectives

Having a clear objective for what you want to achieve gives you more drive to learn. I believe that this is one of the reasons why project-based learning is such an effective methodology. You're not learning only for the sake of learning. Learning by creating something gives you the opportunity to apply what you learn, and gives you the determination to get it done. There's more satisfaction in creating something you wanted to make than there is in solving a hypothetical problem.

When you're creating with technology, you're not only learning about that technology, but also developing some of your soft skills. Rarely does a project come to fruition without a little bit of a struggle. Creating projects often takes patience, persistence, and grit. These are characteristics that you won't learn in a textbook or from a lecture.

After a lot of persistence getting my Python script just right, I sent the file to be printed as a bound volume of emails. When I received it in the mail the following week, I was so pleased with how the project turned out. The source of much of that satisfaction was how much I learnt in order to achieve that goal. I didn't just learn to create. I created to learn.

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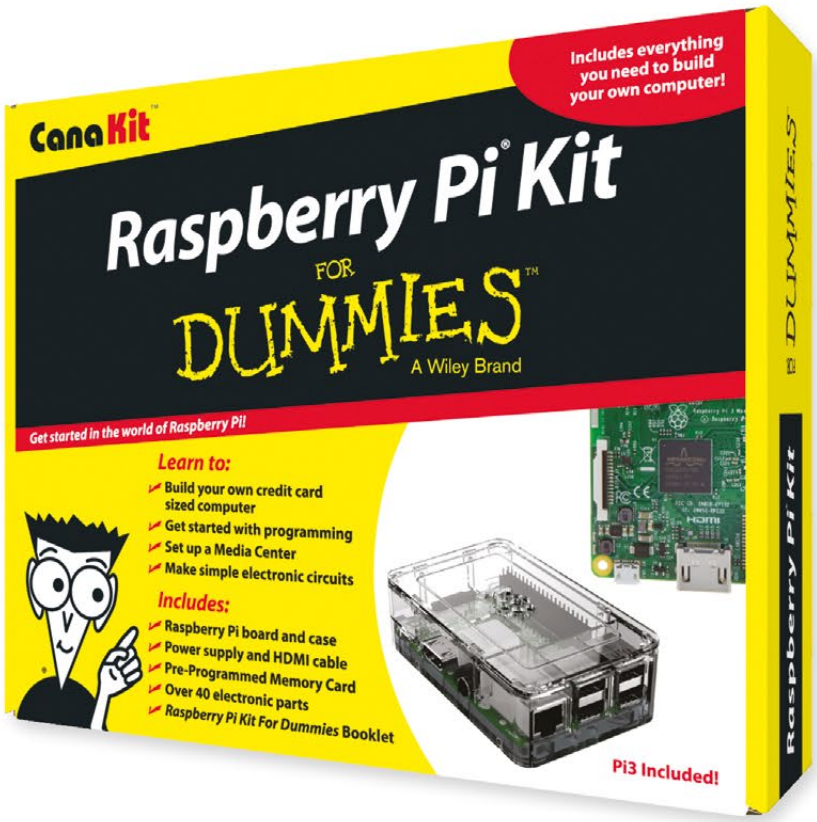
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